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THE PRINCIPLE OF QUINQUENNIAL GRANTS

In recent years there have been comments from both interested and disinterested sources on the success with which the University Grants Committee has carried out its task of allocating Government funds to British universities. It is a task which has required much knowledge and care, though it may be open to question whether this is realized by those advocating the application of a similar device in other fields of activity depending on Government support. However that may be, it is worth while examining some of the suggestions which have been made for new bodies on the lines of the University Grants Committee.

The fields suggested are varied, but they have one feature in common : they all require as a condition of efficient working that there should be a longer period than the calendar year for the review of their projects or activities. The last annual report of the Advisory Council for Scientific and Industrial Research, for example, was concerned at the adverse effect on the work of the Department of Scientific and Industrial Research of sudden or unexpected limitations in the Department's budget, and the absence of reasonably firm budgetary expectations for several years ahead. The Council's plea that the Department should at least be given the flexibility which the right to carry over unspent money from year to year would confer, found strong support in a subsequent debate in the House of Lords last June.

A like difficulty has been encountered by the British Institute of Management, which has also pointed out the impossibility of arranging for the efficient conduct of research on a year-to-year basis with no budgetary certainty. The British Council, in quite another field, has encountered the same difficulty, and the Government's handling of the question of overseas information services on a year-to-year basis has already called forth some well-deserved criticism. Nor will it have escaped notice that the Tweedsmuir Committee, in presenting its proposals for the reorganization of the Imperial Institute, recommended that the system of grant should be placed on a quinquennial basis. The success of the scheme which it advocates would, it is urged, "be prejudiced from the beginning if those in charge of it only know from year to year what money they can count on from official sources, and are limited to budgeting expenditure on a rigid annual basis". More specifically than the other bodies already mentioned, the Tweedsmuir Committee mentioned the University Grants Committee, and its comment is worth quoting : "It is the common experience of organizations responsible for educational and cultural relations that their programmes are liable to be seriously affected, and at times actually frustrated, if they are tied to annual budgets, so far as Government subventions are concerned. We need do no more here than quote the example of the University Grants Committee, which owes its admittedly successful operations over a number of years to the fact that it has been able to plan its grants to Universities

on the basis of quinquennial programmes. We strongly urge that the new Institute be treated on a similar basis, both in regard to recurrent and non-recurrent expenditure".

What is here contended is that the administration of Government funds should be effected by methods appropriate to the purpose of that expenditure, and not by methods determined primarily by financial convenience. The argument is not invalidated because public ignorance of the Imperial Institute, to which the Tweedsmuir report testifies, would militate very considerably against the success of the device in that instance. As part of a general scheme for securing the wise and efficient expenditure of public money on educational and cultural purposes, the new Institute might well be included. If some such device cannot be found, the Tweedsmuir Committee gives clear warning that it would be wiser to abandon pretence and accept the humiliation of closing the Institute and putting the premises to other use.

Some very clear thinking will obviously be required before any such scheme of quinquennial budgeting and accounting could be formulated. The device, or rather its extension, is likely to be opposed by the Treasury on traditional grounds. Such opposition should be overcome by demonstrating the wastefulness and inefficiency of the annual system; and accordingly every care should be taken that no claims are advanced which cannot be fully substantiated as being in the public interest on that ground alone.

Nor is reception by the Government likely to be favourable, if only for the reason that some further slice of public expenditure is removed from immediate control and that an incoming Government will be bound, possibly for several years, by the allocations of its predecessor. That case, however, is equally answerable. It should be emphasized that the object is, not the elimination of control, but the exercise of control where it will be most effective and ensure that expenditure already incurred is not wasted by short-sighted action. Nor, where scientific or technical research is concerned, should there be any hesitation in pointing out to-day the fallacy of imagining that under present conditions any efficient economy in national expenditure can be achieved without touching the categories in which it is now mainly incurred.

That brings us back once more to the question of public understanding and appreciation of what is involved, and public discussion must proceed while the exact means for providing the appropriate control are elaborated. Research is obviously one broad category to be covered, and the trend of questions in recent months in the House of Commons regarding expenditure on the Department of Scientific and Industrial Research, with the Government's abandonment of even the planning of a Science Centre, have increased the misgivings which were brought to a head by the Advisory Council's report. Much fundamental research is already safeguarded through the grants made under the University Grants Committee; but these amount to a small fraction only of the national expenditure on scientific and industrial research. Whether under the Lord President of the Council the functions of the Advisory Council on Scientific Policy could be developed to provide the appropriate safeguards for Parliamentary grants for scientific and industrial research in general might at least be worth examining.

The position of the social sciences and of bodies like the British Institute of Management requires further consideration. It is conceivable that a 'Social Grants Committee' might meet the situation; but there are obvious difficulties and objections. On the research side it might overlap the functions of the University Grants Committee, unless university institutions were clearly excluded. Even with such exclusion, the Committee could scarcely frame its grants without full knowledge of the social research at university institutions, and there is at present no social science research council which could assist. Furthermore, while it might be simple for such a body to cover the new Imperial Institute, the activities of the British Council are another question, particularly in view of the relation of its overseas activities to those of other, including Government, bodies now being considered by the Overseas Information Services Committee.

Here it may be observed that while the Clapham Committee on the Provision for Social and Economic Research, reporting in July 1946, rejected as premature the proposal for a Social and Economic Council on the lines of the Medical Research Council or the Advisory Council for Scientific and Industrial Research, it recommended consideration of the establishment, under the University Grants Committee, of a sub-committee to advise on matters relating to the social sciences. The Committee was clearly alive to the importance of continuity in such research, and the need for financial arrangements other than on an annual basis has been endorsed by subsequent experience as well as by the practice of the Nuffield Foundation and the United Kingdom Carnegie Trust in making their grants. Something wider is, however, required; though it requires consideration whether it is possible for all such grants for social and cultural purposes to be administered through one body, or whether some other arrangement, for example, under the Lord President of the Council or a sub-committee of the Advisory Council on Scientific Policy, would be wiser.

From the point of view of recruiting and retaining staff for overseas information work, long-term planning is essential. In any event, the need for co-ordinating the activities in this field of the British Council, the external services of the British Broadcasting Corporation and the work of the Central Office of Information, leads to a similar conclusion. It may be recalled, moreover, that the Select Committee on Estimates itself, in its ninth report for the session 1951–52, recommended, as a result of its inquiry into overseas broadcasting, a system of quinquennial grants for the overseas services of the B.B.C., in order to enable the Corporation to plan ahead for reasonable periods in providing what is essentially a long-term project.

As has been observed earlier (see *Nature*, **170**, 634; 1952), the administration of such grants and the continuing scrutiny of the appropriateness of particular services to changing conditions may well involve the establishment of an independent body on the lines of the University Grants Committee. On practical grounds there will be objections to multiplying such bodies, and some hard thinking will be necessary to determine the minimum which will serve the objective, without either overlapping or failing to provide support and continuity where they are required in the national interest. Provided, however, these objectives are clearly defined, the task is not insuperable, and the attempt to discharge it could promote that clearer mutual understanding between the scientific man and administrator, using these terms in their widest sense, which is an essential condition for the functioning of devices of this type.

The recent memoranda published by the U.S. Commission on Financing Higher Education (see *Nature* of February 14, p. 273) are a most welcome contribution to the clear thinking that is essential to secure the smooth functioning of the University Grants Committee system in future, still more its extension into other fields. First there must be a large measure of public understanding of what is required, of the importance of the method of control or accounting being adjusted, not primarily to administrative or budgetary convenience, but to the purpose to be served—scientific, technical, cultural or educational. Without that understanding, adoption of such a system is unlikely for long to provide bodies such as the British Council, the British Institute of Management, the Imperial Institute or even the British Broadcasting Corporation, which are ill-equipped with defences such as the universities still enjoy against infringements of their autonomy, with the necessary safeguards for continuity of their research and like activities. That task of education should be the first to be tackled. It extends somewhat beyond the field over which the Parliamentary and Scientific Committee is normally active; nevertheless, the Committee could play an important part so far as science is concerned, whether we are concerned with the physical sciences or the social sciences. The Committee already enjoys a large measure of goodwill which should make it considerably easier to promote a clearer understanding between the administrator—Minister or Civil servant, member of Parliament—and the scientist or technologist. What is important is that no exasperation over the mistakes or follies of the past should be allowed to impede the co-operation in this task of public education of all who understand what is involved, whatever their primary interest may be. The extension of any such device must be advocated solely on the grounds of national interest—whether economic, social, technical or scientific—and of its appropriateness to the purpose to be served; its adoption for any particular purpose or field must be supported by a resolute and sustained effort to secure the sympathy and understanding of all affected, no matter how unfortunately the situation may have been prejudiced in the past.

ADOLF VON BAEYER: CHEMIST AND MAN

Adolf von Baeyer, 1835–1917
Von Karl Schmorl. (Grosse Naturforscher, Band 10.) Pp. ix+214. (Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H., 1952.) 12.50 D. marks.

ADOLF VON BAEYER was born in 1835 and died in 1917. His astonishingly long period as an active worker in chemistry extended from the early days of the classical theory of organic molecular structure until the coming of sub-atomic chemistry: his first research paper was published in 1857 and his last in 1915, at the age of eighty. Soon after Bunsen had succeeded Gmelin at Heidelberg in 1852, the young Adolf Baeyer went to his laboratory from Berlin as a *Doktorand*. Being attracted to organic chemistry, Baeyer soon attached himself to Kekulé, then a little-known *Privatdozent* at Heidelberg. Baeyer's work with Kekulé, on arsenic methyl chloride, brought him the Berlin doctorate in 1858, a historic year that witnessed the publication of Kekulé's fundamental theory of organic molecular structure.

From the Gewerbe-Institut at Berlin, Baeyer migrated to the Strassburg chair in 1872, and three years later he succeeded Liebig at Munich. It was at Munich, with the aid of a galaxy of collaborators whose names were later to become household words in chemistry, that Baeyer carried out the long and varied series of researches which entitled him to be regarded as the founder of modern structural organic chemistry. One of his most famous pupils, W. H. Perkin, jun., to whom Baeyer became "the object of a lifelong intellectual devotion", selected his researches on indigo and its derivatives as "among the most brilliant in the whole range of organic analysis and synthesis", and characterized his "schwere, scheussliche und gefährliche" researches on the reduction of the phthalic acids as "so masterly in all their details that they must always remain as a monument to Baeyer's experimental skill and theoretical ability".

The book under review, which is the first comprehensive biography of Baeyer to be published, gives a concise and documented review of his contributions to organic chemistry; but it is chiefly remarkable for a good deal of new material, including some interesting illustrations, relating to Baeyer's ancestry, family circumstances and personality. In 1932, Prof. Hans Rupe, of Basle, published some charmingly written reminiscences of life in Baeyer's laboratory in the early 'nineties of the past century (*Nature*, **131**, 294; 1933). This and other sources have been drawn upon by the present biographer in building up an edifying picture of the personality of this great chemist. In these references the celebrated 'Bleikammer', or 'lead chamber', naturally looms largely; such was the name given to the room in which Baeyer submitted students of pharmacy and medicine to oral examinations, which included, at one time, exhaustive questions on the lead-chamber process for making sulphuric acid.

Baeyer had certain unorthodox characteristics as an examiner, such as turning his back upon the candidate, giving him abruptly a time limit for each question, and tapping impatiently with his pencil while the unhappy victim was considering what to say. "What do you see having a red colour when you go into a pharmacist's shop? You have two

minutes in which to answer." On such occasions Baeyer was apt to formulate questions designed (in his opinion) to make the candidate think, rather than to reproduce book knowledge. One can imagine the *Examensangst* (expressive word !) of an aspiring pharmacist when asked suddenly: "What happens when a red cyclist collides in the street with a Munich tramcar ? You have three minutes in which to answer". When the second-hand of the examiner's watch reached the prescribed mark without the astonished candidate having referred to the effect of bringing together the primary red and blue colours, Baeyer would admonish him: "Sie müssen denken lernen !" Naturally, there was another side to all this, and at intervals unofficial collections of Baeyer's questions were issued in the form of a 'swot book', or, to give it a more dignified name, an *Examensfragenheftchen*; and Baeyer found it increasingly difficult to hit upon new questions.

Altogether, this is an informative and entertaining book, deserving of a wide welcome from chemists and others.

JOHN READ

PSYCHIC REMINISCENCES

Telepathy and Spiritualism

Personal Experiments, Experiences and Views. By Dr. J. Hettinger. Pp. 150. (London: Rider and Co., 1952.) 16*s*. net.

Psychic Oddities

Fantastic and Bizarre Events in the Life of a Psychical Researcher. By Hereward Carrington. Pp. 183. (London: Rider and Co., 1952.) 16*s*. net.

IN these two books by, respectively, Dr. J. Hettinger and Mr. H. Carrington, the authors summarize some of their experiments and conclusions in psychical research.

The first is an account of Dr. Hettinger's personal attempts to arrive at the truth regarding telepathy and spiritualism. In the course of his discussion he provides abstracts of some of his previously published works, including his two books, "The Ultra-Perceptive Faculty" and "Exploring the Ultra-Perceptive Faculty", which deal with his investigation of the alleged faculty of certain persons whereby paranormal knowledge is gained about a person or thing through the use of some object acting as a key or pointer. From the simpler type of experiment, Dr. Hettinger proceeded to an interesting and ingenious "pictorial method" in which he attempted to show that the transmission of the content of illustrated matter could be conveyed to a percipient with results so far in advance of what might be expected by chance or other normal factor that a paranormal explanation had to be invoked.

Before dealing with his own experiments, Dr. Hettinger briefly discusses those of some of his contemporaries, including Dr. S. G. Soal, Mrs. M. Goldney, Mr. Whately Carington and Dr. J. B. Rhine. With regard to many of these experiments, he is of the opinion that they do not, as is often claimed, test the existence of any psychic faculty through statistical evaluation or ascertain the functioning of such a faculty as regards past, present and future.

Although Dr. Hettinger is convinced of the validity of his own findings and their value as pointing the way to various further possibilities, he does not appear to have dealt seriously with the published criticisms of his experiments in relation to the chance factor, bias in the assessment of the results, and inadequacy of the control material. Although, at first sight, it would appear that many of his results are clearly due to the operation of some unknown factor, this feeling is much weakened by a careful scrutiny of the conditions and by the omission in the printed accounts of details clearly necessary to any fair appraisal of the facts. Although the book has both an index and a bibliography, only two items in the latter are dated, and only two give the place of publication, omissions which, in a work of this kind, are difficult to excuse.

In his "Psychic Oddities", Mr. Hereward Carrington, the veteran American psychical researcher, has put together a number of his personal reminiscences coupled with a selected number of odd experiences recorded by others. Unlike Dr. Hettinger, he has made but a few lengthy series of experiments himself, and in this volume he is content to give the reader a lively sketch of mediums, research workers and magicians he has known, interspersed with many amusing anecdotes. Unfortunately, Mr. Carrington has failed to provide adequate documentation for the stories he tells, and thus the reader is debarred from following up the material, tracing it to its source and then judging whether there is any case to answer.

E. J. DINGWALL

DUNS, SPINNERS AND SEDGES

An Angler's Entomology

By J. R. Harris. (New Naturalist Series.) Pp. xv+268+48 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1952.) 25*s*. net.

TO the entomologist the fly-fisher's nomenclature is baffling. His almost mystic faith in some particular artificial fly, on a particular stretch of water, on a particular evening is impressive, especially when he is successful; and yet, somehow, it savours far more of chance than of sound intention.

Mr. J. R. Harris takes us right into the heart of these arcana, not as an iconoclast debunking the whole mystery but as an angler and entomologist who, more successfully than his predecessors, has tried to make sense of it. His is the right approach for the fisherman, because it starts from what he knows and has experienced—from his 'known' to his 'unknown'. This book is not a treatise on aquatic entomology: it is what it purports to be, an angler's entomology dealing with the questions the intelligent angler asks and the information he seeks. Without obtruding systematic entomology, it brings the work of Kimmins and Hynes—to mention only two systematists—to the assistance of the fisherman in unravelling the almost bewildering assortment of names given by his forbears to the flies he uses and the insects he sees.

It deals first with the Ephemeroptera or mayflies (duns and spinners), describing without too much detail their life-histories and habits, their enemies and their place in classification. Then follows a similar but shorter account of the Trichoptera or caddis-flies (sedges), the Perlidæ or stone-flies and a few Diptera like *Bibio* and the Chironomids. All this is straightforward, sound entomology. Next in the final third of the book come chapters on "Period Flies and Fish", on the taste and sight of fish, on

those flies which are more attractive to fish and on fly dressing. There are four appendixes giving a list of angler's insects, keys to duns and spinners, descriptions of Ephemeroptera and hints on fly dressing.

The book is handsomely illustrated: one illustration in particular, of a stretch of water on the River Teith, gave me a sharp fit of nostalgia. Distribution maps and a good bibliography complete the angler's fare.

The special interest of this book lies in its combination of fisherman's lore and entomological science, in which neither is allowed for too long to dominate the other. Some of the author's comments are shrewd and worth noting, such as that while dichotomous keys afford the best scientific means of identifying an insect, really the best way is to be so familiar with the insect as to know it by sight, a method employed long after the diagnostic characters of the key have been forgotten. How true we know that to be. Then it is interesting to note that it may be more easy to identify an insect not from a dead specimen but from its effigy. Here again, long experience and intuition, only to be passed on in practice, can remind the man of science that his vocabulary is still too limited or his observation subconsciously too acute to allow him to record and describe all.

To me the best thing about this book is that the author never suggests that angling may become a science. To him, as to all true anglers, it is an art, and it would indeed be a bad day for us if all the rods on the river were equally lucky because everyone knew which ephemerid to put on. There are two questions one would like to ask the author: Why are the *Cænis* species called the "Angler's curse" and what has happened to "Jock Scott"?

J. W. Munro

REFERENCE BOOK OF INTERFEROMETERS

Modern Interferometers

By C. Candler. Pp. 502. (London: Hilger and Watts, Ltd., 1951.) 57*s*. 6*d*. net.

FOR many years Ewart Williams's "Applications of Interferometry" has been a standard British reference for physicists: the fact that a hundred-page monograph should occupy such a position for so long is evidence of the need for a more comprehensive work on interferometry. C. Candler's book goes far to satisfy this need. Whereas Williams treats the subject from a theoretical point of view and describes interferometers as examples of a particular class, Candler generally discusses a whole range of instruments in a more-or-less arbitrary order. For this reason the book is somewhat discontinuous, but is very suitable for the practical scientist who wishes to learn something about an instrument he has to use. Two-thirds of the book are devoted to interferometers, and the remainder to diffraction gratings.

The first chapter outlines the proposed arrangement of the material adopted. Instruments are to be grouped according to their functions: the measurement of difference in optical path, of length, of wave-length and of refractive index, and the analysis of hyperfine structure. This system is barely recognizable in the ensuing chapters, however. Chapter 2 deals with suitable light sources and factors affecting the widths of spectral lines, while Chapter 3 discusses the fundamental standards of length, although descriptions of the determination of the length of the metre in terms of light wave-lengths are deferred to Chapters 5 and 19.

Chapter 4 deals with interference effects in thick plates and thin films, and includes accounts of non-reflecting films, interference filters and surface finish; in connexion with the last, it is misleading to suggest that the technique adopted by Timms is very similar to that employed by Tolansky, as in only one of these is multiple-beam interference utilized. The next three chapters describe the principle and application of the Michelson interferometer and its derivative due to Twyman and Green. Bates's wave-shearing interferometer receives only two pages, with the Mach–Zehnder interferometer mentioned only (a diagram of one version of this instrument is also included at the end of the book). An account of the latter applied to the examination of fluid flow, as in wind tunnels, would have been a useful addition.

Interferometers used in the measurement of length and angle gauges are described in Chapter 8. The inclusion of an optical measuring machine and an optical comparator, neither employing interference, appears irrelevant. In Fig. 8.3 (p. 195) the author states that the prism has been drawn oversize "to avoid violating the laws of optics": a more serious violation is the inclusion of an eyepiece in the diagram, as with this arrangement the observer merely views an image of the pinhole. The eye is, of course, placed in the plane of the pinhole; a telescope of low power can both transfer this to a more convenient position and slightly magnify the gauges under examination.

Chapter 9 describes the Fabry–Pérot étalon and its use in the determination of the metre, while the next chapter deals with the stellar interferometer. Reflexion and transmission échelons are considered in some detail in two further chapters. An an illustration of the rather discontinuous treatment, Chapter 13 returns to the Fabry–Pérot étalon, dealing with its application to the measurement of wave-length and to the analysis of hyperfine structure. A chapter is allocated to the Lummer–Gehrke plate: the statement that this interferometer employs a process combining diffraction with refraction should surely read—reflexion with refraction. Four chapters on diffraction gratings follow, covering plane and concave gratings, their ruling, properties and methods of mounting. A short account of grating replicas is included; but no mention is made of developments during the past few years. Three short, concluding chapters describe the Fabry–Pérot étalon as a refractometer, and the Rayleigh and Jamin refractometers.

Numerous references are listed at the end of each chapter, with additional ones given in an appendix. The book already covers an enormous field, but, from the point of view of completeness, micro-interferometers might well have been included; the only reference is two paragraphs on the interference microscope. Space could have been found by the omission of irrelevant material, such as the examples quoted. Diagrams and script are clear, and the style is very readable. Because of the distribution of material, however, it is more suited as a book for reference than for general reading.

K. J. Habell

BASES OF MICRO-CLIMATOLOGY*

By Sir DAVID BRUNT, F.R.S.

THE most fundamental factor which has to be taken into account in micro-climatology is the incoming solar radiation by day, and the long-wave radiation and absorption by the atmosphere and the surface of the ground. Over bare soil the absorption and emission of radiation by the earth are both brought about by a very thin layer of soil. When the soil has a covering of vegetation, the effective locus of both absorption and radiation may be situated at any level between the solid surface of the ground and the top of the vegetation, and this locus may be a layer the depth of which will depend on the character of the vegetation.

The main factors which control the change of temperature of the surface and of the air in contact with it, as a result of the transfer of heat by radiation and absorption, are the nature of the soil, soil drainage, vegetation, contour of the ground, aspect of the ground and nearness to large sheets of water.

Climatology of Bare Soil

The climatology of bare soil is relatively simple. When the surface of the ground is heated by the absorption of incoming solar radiation by day, or cooled by the loss of heat by long-wave radiation by night, the gain or loss of heat at the surface is in part compensated by conduction to or from lower layers. It can be shown that in given meteorological conditions, or in other words, for a given rate of gain or loss of heat from the surface, the rate of change of surface temperature is proportional to $1/\sqrt{ks}$, where k is the coefficient of thermal conductivity of the soil, and s is its heat capacity[1]. Since soil is an aggregation of solid particles with the spaces between them filled with air or water, both the conductivity and the heat capacity will depend upon the extent to which these spaces are filled with air or with water. Since both the conductivity and heat capacity of air are very small, it follows that for a soil containing much air $1/\sqrt{ks}$ will be great, and surface temperature will vary rapidly when there is a net gain or loss of heat at the surface. Thus a sandy soil will have a large diurnal variation of surface temperature, and this is well exemplified by a comparison of meteorological observations at South Farnborough, on a sandy soil, with simultaneous observations at Croydon, on a chalky soil. The observations were taken during March 28–29, 1933, during a short spell of clear weather. (The Rickmansworth observations will be referred to later.)

Table 1

	Max. March 28	Min. March 29	Range
Croydon	65° F.	35° F.	30° F.
South Farnborough	69	30	39
Rickmansworth	66·9	21·4	45·5

Thus the lighter the soil the warmer will be the clear afternoons and the colder the clear nights.

When the air within the soil is partially replaced by water, which has a higher conductivity and heat capacity, the variability of temperature is diminished. The fact that the fall of temperature from sunset to sunrise is much greater in summer than in winter, in spite of the fact that the time-interval from sunset to sunrise is much longer in winter than in summer, is due to the higher water content of the soil in winter. Water-logged soil has a lower diurnal variation of temperature than dry soil, or well-drained soil; but on undrained soil the evaporation of water from its surface maintains the surface temperature at a lower level by day and by night than on the same soil when well drained.

Soils may be arranged in the following order of decreasing diurnal variation of surface temperature: sandy soil, light loam, chalky soil, heavy loam and clay.

On clear nights the surface temperature of snow falls well below that of bare soil, since snow is about nine-tenths air. But, underneath a layer of snow only a few inches deep, the ground temperature has been observed to remain steadily at 0° C., while the upper surface of the snow varied from − 15° to − 4·6° C.

Effect of Vegetation

The air above grass is colder by night and warmer by day than air above a bare surface. This is the joint effect of the trapping of air between the grasses, and of the poor conductivity of the soil-layers in which the roots are embedded. The first cause is more effective among tall than among short grasses, while the second may have very great effect where the grass root systems form a mat of horizontally running stems below the surface of the soil, such as one finds on the Romney Marshes. Evaporation from the surface of the grass leaves must also contribute to the lower night temperature.

A. Ångström[2] found that, in a field of grass 1 m. high, the incoming solar radiation was 1·08 cal. cm.$^{-2}$ above the grass, decreasing to 1·04, 0·28 and 0·19 cal. cm.$^{-2}$ at 0·5, 0·1 and 0 m., respectively, above the ground surface. The highest afternoon temperature and the lowest night temperature might thus be expected to be about 10–20 cm. above the ground, where the grasses are dense enough to absorb most of the radiation downwards. The same layer should be the effective outward radiating surface at night, and so the level of lowest temperature.

Similar results were derived by R. Geiger[3] in a field of winter rye. When the rye was short, radiation passed readily down to the ground; but after its height had grown beyond 0·5 m., the lower leaves showed rapid growth and formed the effective absorbing and radiating layer. The highest temperature by day and the lowest temperature by night were to be found at the highest level at which the lower leaves formed an effective obstacle to the downward passage of solar radiation by day and the upward passage of long-wave radiation by night. As the crop ripens the lower leaves wither, and the height at which the day and night extremes of temperature occur decreases but does not fall to zero. Cornfields surrounded by meadows are found on sunny afternoons to be sources of strong convection currents, in which a sail-plane can soar readily.

Within a bed of antirrhinums, at an early stage of growth the horizontal leaves offer a complete barrier to the passage of radiation in either direction. With well-developed plants the highest temperature during

* Based on a lecture delivered at Wye College, Kent, on December 4.

the afternoon is at about the level of the uppermost leaves, while the temperature falls off with distance from this level both upwards and downwards. Again, on a clear night the upper leaves form the effective outward radiating surface of the plants. The air cooled by the cold leaves can sink down to the ground, while partially mixing with the air below. The result is to yield the lowest air temperature at the ground, with an inversion of temperature up to levels above the uppermost leaves of the plants.

In a forest with a thick canopy of leaves, the uppermost layer of the canopy is the effective absorbing and radiating layer. On a sunny day the ground below the trees, and the air immediately above it, remain cooler than the ground and the air above it in the open. On a clear night the air cooled by contact with the upper leaves of the canopy sinks to the ground, with the result that the air immediately above the ground is slightly colder than the air at the level of the canopy. In clear weather the air temperature at the ground is at all times lower than that of the air at the top of the canopy, and is lower by day and higher by night than the air temperature over open ground.

In a wood which has not a complete canopy of leaves, or among such plants as raspberry canes, some sunshine penetrates to the ground, and some is absorbed by the trunks of the trees. Day temperatures will then be intermediate between those in a forest with dense canopy and those in the open.

Some typical temperatures, observed by C. E. Cornford at East Peckham, Kent, on the morning of May 30, 1937, are given in the table below[4], these being minimum temperatures measured at 3 ft. above the ground.

Table 2

Bare soil	49·5° F.	Meadow close cropped	45·7° F.
In wood	49·0	Meadow longer grass	43·0
Among raspberry canes	48·2	Grass and clover	43·5

An unusual type of vegetation, judged by our experience of British trees, is the mallee scrub of Australia. The individual mallee tree has a number of trunks growing up from the same root, and its leaves hang downward vertically. The leaves thus help to check the horizontal movement of air, but allow radiation from the ground to pass outward freely, so that the temperature falls well below that over open ground. Any area covered with mallee scrub acts as a source of cold air.

Effects of Contour

On a clear night the surface of the ground is cooled by radiation, and cools the air immediately above it. The cooling of the air is greatest over grass, especially over long grass. On sloping ground the cold air flows down the slope much as water would, yielding what are known as 'katabatic winds'. The cold air flowing downhill fills any hollow in the ground, and accumulates at the foot of the slope unless there is some ready exit which it can follow. The effect of accumulation in a valley-bottom of cold air from the slopes above is illustrated by the data in the last row of Table 1. The data refer to a station in a little sheltered valley which runs into the valley of the River Chess about halfway between Rickmansworth and Chorley Wood. At this station the diurnal range of temperature was 50 per cent higher than at Croydon. It is clear that neither a sheltered valley nor the lower reaches of an extensive grass-covered slope can offer an ideal location for either a home or an orchard. In some cases it is possible to deflect the current of cold air sideways by means of a diagonally running wall or thick hedge, or hessian screen, and so minimize the discomfort or damage such cold air can produce.

It was noted earlier in this article that over a snow surface the air can cool at night to temperatures far below those which would be found over bare or grassy ground similarly situated. Sloping snow-covered ground can therefore produce very strong katabatic winds, which can attain very high speeds down valleys which are fed with cold air from the sloping sides over extensive areas. Very strong katabatic winds are formed in this manner in valleys on the Antarctic continent.

Effect of Aspect

B. A. Keen[5] states that on a slope facing south the soil temperature at 1½ in. below the surface may be as much as 15 deg. F. higher, with a correspondingly lower moisture content, than on a slope facing south. Aspect can thus have an important bearing on the local climate.

Effects of Nearness to Large Sheets of Water

The diurnal variation of the surface temperature of deep water is small enough to be negligible by comparison with that of the ground, and places near large sheets of deep water will have a climate comparable with that of the seaside.

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BIOSYNTHESIS AND ENERGY TRANSPORT BY ENZYMIC REDUCTION OF 'ONIUM' SALTS

By Dr. D. W. WOOLLEY

Rockefeller Institute for Medical Research, New York, N.Y.

THERE has been such marked success in the understanding of the mechanism of simple enzymic syntheses, and of how energy is transferred in the course of carbohydrate metabolism, through use of the concept of an energy-rich phosphate bond such as that contained in adenosinetriphosphate, that among biochemists it is generally conceded that both the synthesis of a variety of chemical constituents of living matter, as well as the controlled transfer of energy in processes of life, probably occur through the functioning of 'active' or energy-rich phosphate esters and anhydrides. The purpose of this article is not to dispute this concept, because a vast amount of existing evidence makes it seem quite probable that carbohydrate fuel is burned, and the energy is captured for other vital functions by the intervention of such phosphorus compounds. Rather, it is my purpose to point out that living matter contains enzymes which bring about special types of syntheses, and that these reactions are not driven directly by the energy contained in phosphate compounds. In fact, phosphorus is not concerned in some of the biochemical syntheses. The energy which appears to

drive these reactions seems to reside in quaternary ammonium ions or in sulphonium ions, and is liberated when these 'onium' compounds are reduced during the course of the reaction. In the case of the quaternary substances the reduction is from nitrogen of a valence of 5 to tertiary bases in which nitrogen has a valence of 3, while in the sulphonium compounds sulphur changes in valence from 4 to 2. The term 'valence' is used here because it simplifies the presentation. It denotes merely the number of bonds. However, the electronic transfers can be appreciated much more if one states that nitrogen in the quaternary ammonium compound acquires a pair of unshared electrons when it passes into the tertiary base. In the quaternary compound, this pair was shared with a carbon atom as a covalent bond. In other words, nitrogen in the tertiary base has acquired sole possession of the two electrons which, in the quaternary salt, it shared with carbon. Similarly, with the sulphonium compounds, the changes in shared electrons are not emphasized by the use of the term 'valence'.

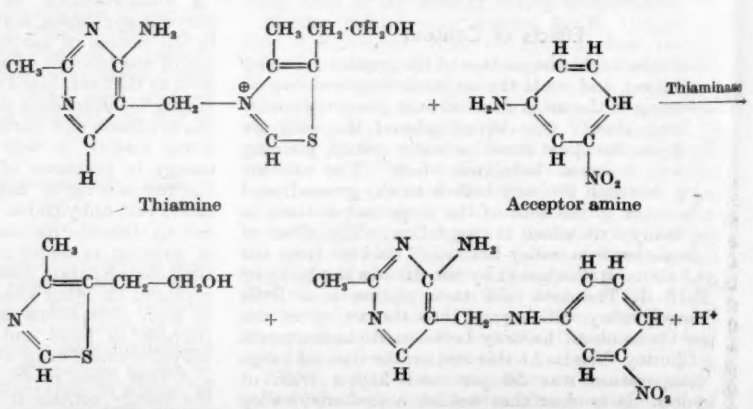
It seems probable, as will be discussed below, that some peculiarly useful properties arise from reactions in which 'onium' compounds are reduced, and that living organisms may employ them partly for this reason. In any event, these enzymic syntheses through the reduction of 'onium' compounds constitute a new mechanism for the formation of special substances and for the transfer of energy in living organisms.

The views of the author on this subject have arisen from a study of the enzyme of carp which destroys thiamine (aneurine, vitamin B_1). Because of this, let us consider the action of this enzyme, and substantiate the argument with other examples which have arisen in recent years.

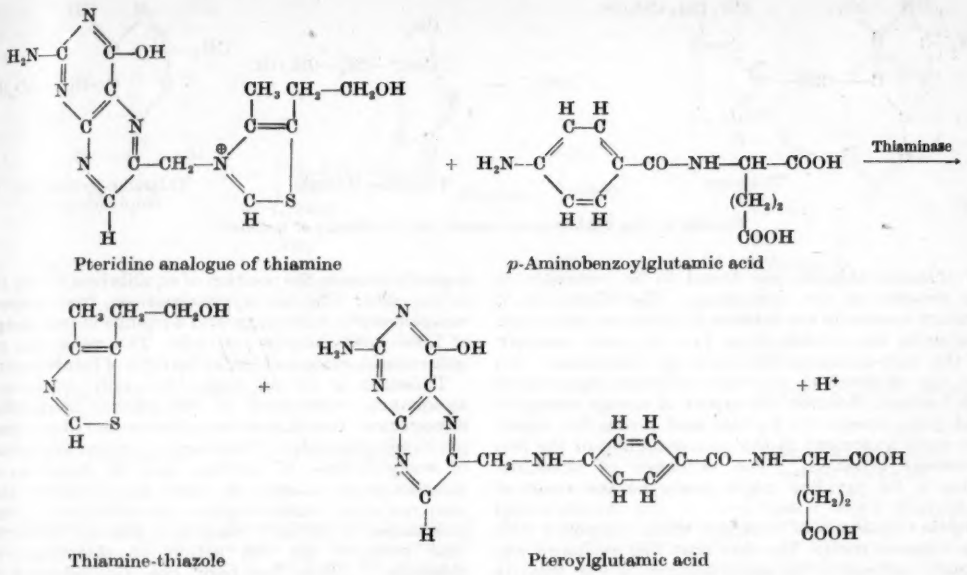
The existence of carp thiaminase, that is, an enzyme in carp which actively destroyed thiamine, was detected in 1941[1,2] after it had been noted that the feeding of ground raw fish to foxes called forth an epidemic disease which could be prevented or cured by injection of this vitamin[3]. The enzyme could be extracted from the fish by means of hypertonic salt solutions, and could thus be obtained free from cells. Subsequent investigations by many workers have revealed a similar enzyme to be present in such diverse living things as clams, several species of fresh-water fish, certain micro-organisms, and bracken ferns[4]. Somogyi[5] has also detected the ability of mammalian organs to destroy thiamine, although, in my experience, this ability of mammalian tissues, if it exists, is slight in comparison with that of carp and clams. Nevertheless, such thiamine-destroying enzymes seem to be widely distributed in diverse organisms.

The fact that carp extracts actually destroyed thiamine and did not merely sequester it was shown by the isolation of the products formed[6]. This demonstration, along with the heat lability and dependence on *p*H and temperature of the vitamin-destroying activity of the tissue[6], indicated that an enzyme was involved. This enzyme was called 'carp thiaminase'. It has been purified by ammonium-sulphate fractionation[7]. The products which it formed were the thiazole moiety of thiamine (that is, 4-methyl-5-hydroxyethylthiazole), and a conjugate which contained the pyrimidine portion of the vitamin. A secondary reaction proceeding in carp tissues was recognized. This led to the formation of the free pyrimidine moiety of thiamine, 2-methyl-4-amino-5-hydroxymethylpyrimidine, from the conjugate formed in the main reaction. Clearly, then, the enzyme attacked thiamine and liberated the thiamine-thiazole, and at the same time attached the pyrimidine half of the vitamin to something else. It is in this latter process—the attaching to something else—that the synthesizing action of the reaction becomes clear.

The nature of this 'something else' was made plain by the work of Sealock and Davis[8]. Earlier investigators[6] had found that the action of carp thiaminase was greatly reduced when solutions of it were dialysed. The dialysable component, which was stable to heat, was considered to be a coenzyme. However, there was a strange property of the reaction which had caused much wonder in the early investigations. This was that a given quantity of enzyme would destroy a definite amount of thiamine very rapidly; but when more substrate was present, no more was destroyed, even during prolonged incubation[6,7]. Sealock and Davis recognized that the enzyme had two substrates, both of which must be present for the reaction to proceed. One substrate was thiamine and the other was the dialysable component. However, the second substrate was not specific, because any one of a variety of amines could serve. Thus, in the work of Sealock and Davis, either *meta*-nitroaniline or *meta*-aminobenzoic acid was effective. In clams, this second substrate appears, from the work of Barnhurst and Hennessy[9], to be probably the amino-acid taurine (positive identification has not yet been accomplished, but the evidence in Barnhurst and Hennessy's and subsequent papers strongly suggests that the situation is as stated). So long as both substrates, that is, thiamine and a suitable second component, were fed into the reaction system, the enzyme continued to function, and did not stop in the puzzling fashion just mentioned[7,8]. The very



Equation 1. Carp thiaminase reaction with *m*-nitroaniline as acceptor



Equation 2. Synthesis of pteroylglutamic acid by the action of carp thiaminase

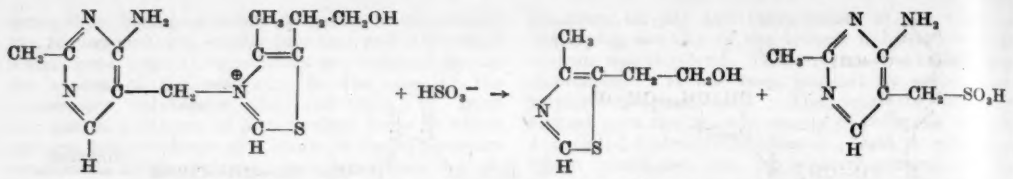
great activity of carp tissues in destroying thiamine can only be appreciated when the second substrate, which we may call the acceptor amine, is added. In fact, measurements of the quantity of thiaminase in tissues which were made prior to this discovery are of very questionable value. The true enzymic content can only be found when both substrates are present in excess.

The reaction catalysed by thiaminase can now be formulated in the manner shown in equation (1). The biochemical synthesis which this enzyme brings about thus becomes plain. It is the alkylation of the acceptor amine with the pyrimidine portion of the thiamine molecule. In the case of clam tissue studied by Barnhurst and Hennessy[9], the synthesis involves the alkylation of taurine (the acceptor amine) with this same alkyl group. The product is apparently what has been called 'icthiamine'[4]. Because several primary aromatic, and several aliphatic, amines can each be used readily by the enzyme as its second substrate, a variety of new substances can thus be formed. Some of these products have a complexity of structure which it is gratifying to find an enzyme can produce.

The synthesizing abilities of the enzyme became clear when it was possible to induce it to form a compound of widely recognized biochemical importance, namely, pteroylglutamic acid[10]. The products formed from thiamine and acceptor amine are, as we have seen, thiamine-thiazole and alkylated acceptor amine. Pteroylglutamic acid may be viewed as an acceptor amine (*p*-aminobenzoylglutamic acid) which has been similarly alkylated. The only difference is that the alkyl group has been a pteridylmethyl rather than a pyrimidylmethyl. If, then, the proper pteridine analogue of thiamine were prepared in which the pteridine portion of pteroylglutamic acid replaced the thiamine pyrimidine, and if this quaternary salt were mixed with *p*-aminobenzoylglutamic acid and carp thiaminase, one could reasonably expect some pteroylglutamic acid to be formed (see equation 2). Actual experiment showed that some was, indeed, synthesized[10]. The reaction did not proceed as readily as was the case when thiamine, rather than its pteridine analogue, was one of the substrates. However, this may not be too surprising when the structural differences of the two analogous substrates are remembered. Although this synthesis of pteroylglutamic acid can thus be demonstrated *in vitro*, there is no reason for believing that the actual formation in living organisms follows this course. Rather, this seems to be an experimental model to illustrate the synthetical capabilities of this enzyme.

What is the source of the energy which brings about these syntheses? The reactions proceed with great speed in the absence of any dialysable phosphorus compounds. The true nature of the process can best be appreciated if one recalls a well-known, non-enzymic cleavage of thiamine. The vitamin reacts readily with bisulphite ions according to the scheme shown in equation (3). What is new about this reaction is to recognize that it is an oxidation-reduction. The sulphur in bisulphite is tetravalent, whereas that in the pyrimidine-sulphonic acid is hexavalent. Similarly, the quaternary nitrogen of thiamine is pentavalent, and the tertiary nitrogen of thiamine-thiazole is trivalent. In the reactions catalysed by carp thiaminase, a similar reduction of the quaternary nitrogen takes place. In both cases thiamine is the oxidizing agent, the quaternary nitrogen of which is reduced during the reactions. The author feels that this reduction of the thiamine nitrogen is the source of the energy.

Recently, a series of four papers has appeared in which the true nature of the thiaminase reaction is concluded to be that of base exchange[11]. Pyridine was found to react with thiamine in the presence of the enzyme to give a small yield of a substance in which the thiamine-thiazole was replaced by an unsubstituted pyridine ring with the thiamine-pyrimidylmethyl group attached to the pyridine nitrogen (see equation 4). This exchange of pyridine

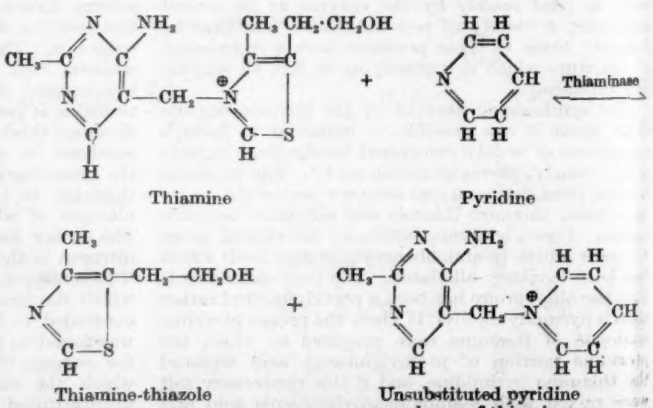


Equation 3. The well-known non-enzymic sulphite-cleavage of thiamine

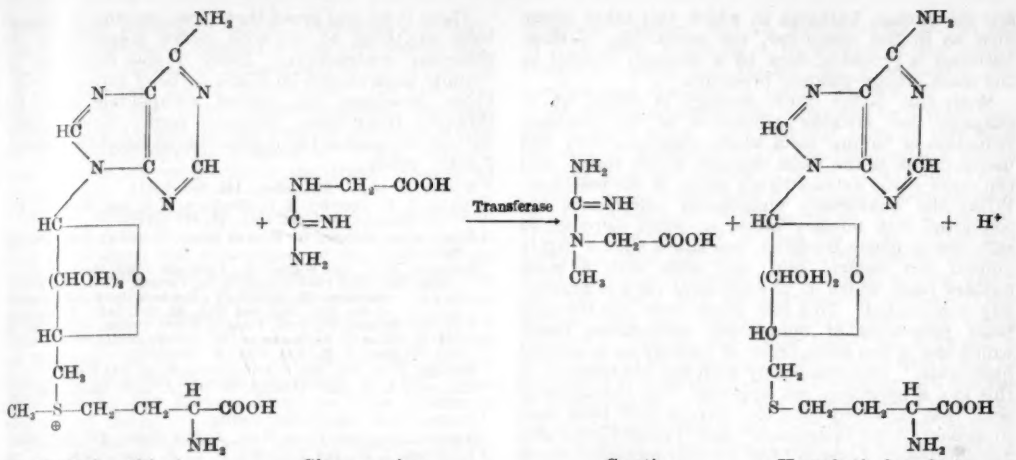
for thiamine-thiazole was found to be reversible in the presence of the thiaminase. The alkylation of primary amines in the manner in which we have been discussing was considered as just one more example of the base-exchange catalysed by thiaminase. To me, the emphasis on the base-exchange character of the reaction obscured the aspect of energy transport and ionic change (to be discussed presently), which are more important in the understanding of the real processes involved. The exchange of thiamine-thiazole for pyridine might easily be the result of a slightly lower energy-level of the unsubstituted pyridine analogue of thiamine when compared with the vitamin itself. The fact that this exchange was readily reversible by manipulation of the relative concentrations of the reactants and products might be in favour of such a view. On the other hand, I am not aware of any experiment in which thiaminase has been shown to reverse the alkylation of primary amines. Thus, when relative concentrations of the substances in equation (1) are manipulated, no one has yet been able to observe any synthesis of thiamine. The only way in which thiamine has yet been formed in such a situation is to utilize the energy of a glycolytic system. Thus, Barnhurst and Hennessy[9] have shown that although icthiamine (presumably taurine alkylated with the thiamine-pyrimidylmethyl group) plus thiamine-thiazole does not yield any thiamine in the presence of thiaminase, thiamine is formed when icthiamine and thiamine-thiazole are incubated with glycolysing yeast. In other words, the only way to reverse (or apparently to reverse) this reaction is to pour into the system a large amount of energy derived from the oxidation of glucose. In terms of the mechanical analogy to be discussed below, the quaternary storage battery must be recharged (that is, the nitrogen must be restored to the quaternary, pentavalent state) by the expenditure of the energy of glycolysis. Mere manipulation of concentrations of participants is not enough. In the case in which pyridine reversibly replaces thiamine-thiazole (as in equation 4), one still has a quaternary salt as the product, even though this pyridinium compound may perhaps be slightly less charged with energy than is thiamine itself. The difference in energy-level of the nitrogen in icthiamine or in the nitroaniline compound of equation (1), from that in the pyridinium salt, may well be of a different order of magnitude.

No exact calculations have yet been made of the change in free energy during the thiaminase reaction pictured in equation (1). This is partly because the position of equilibrium is very far to the right. The best approximations, from indirect measurements, have suggested a change in free energy of 7,000–8,000 Calories per mole. This value may require considerable revision in the light of future results.

Thiamine is by no means the only quaternary ammonium compound of recognized biochemical importance. One thinks also of cozymase (diphosphopyridine nucleotide), of triphosphopyridine nucleotide, of acetylcholine, of choline, and of carnitine, to mention only a few. Is there any evidence that enzymes exist which catalyse the reduction of such substances to tertiary bases in a manner similar to that pictured for the action of thiaminase on thiamine? Thus far only one (in addition to thiaminase) is known; but with the recognition of the basic phenomenon, a concerted search can be made which may uncover others. Up to the present time, progress has depended on chance discoveries. The other example is that of 'diphosphopyridine nucleotidase', or the enzyme which destroys diphosphopyridine nucleotide by cleavage at the quaternary link between ribose and nicotinamide. This enzyme was discovered by Mann and Quastel in mammalian brain and liver[13] and a similar enzyme has been found in other animal tissues. One such has been purified from the cultures of the fungus *Neurospora crassa*[13]. These enzymes attack the quaternary nitrogen in diphosphopyridine nucleotide, liberating nicotinamide, in which nitrogen has now a valence of 3. The other product is ribose-5-phosphate united in pyrophosphate linkage to muscle adenylic acid. This reaction differs markedly in at least one respect from that catalysed by thiaminase. With the diphosphopyridine nucleotidase, no acceptor amine is required; rather, water alone can be said to accept



Equation 4. Exchange of tertiary bases catalysed by thiaminase



Equation 5. Enzymic formation of creatine from 'active' methionine

the aldehydic end of the ribose phosphate portion of the molecule. With thiamine in the thiaminase process, there is no reaction without an acceptor more complex than water (that is, a suitable amine). It may well be that if a suitable acceptor for the diphosphopyridine nucleotidase could be found, the reaction would be greatly accelerated and the activity of the enzyme remarkably enhanced, just as was the case with thiaminase. If this were so, a rather complex molecule could be expected to form as the product, in which would be contained the ribosephosphate-adenylic portion of diphosphopyridine nucleotide.

The need to search for enzymes which act in this fashion on acetylcholine and other biologically important quaternary salts as one of their substrates seems self-evident.

Very recent disclosures have indicated that quaternary ammonium salts are not the only kind of 'onium' compounds which undergo the type of transformation just discussed. The work of Cantoni[14] on the nature of the so-called 'active' methionine has shown that sulphonium compounds exist in Nature and participate in certain important biochemical syntheses. The processes are so similar to those examined with the quaternary ammonium compounds that they warrant our attention. When either creatine or N-methylnicotinamide is synthesized in mammalian tissues, the methyl group which appears in these products arises from the terminal methyl group of methionine. However, methionine itself will not react. Rather, it must be activated by the intervention of adenosinetriphosphate and a special enzyme. When this special enzyme acts on adenosinetriphosphate plus methionine, 'active' methionine is formed. Cantoni was able to isolate this 'active' methionine, and showed, much to his surprise, that it did not contain phosphorus. (The old and established belief would have pictured the phosphorylation of methionine in order to activate it.) Rather, he showed that the 'active' methionine was a sulphonium salt in which adenosine had been added to the sulphur atom of methionine, thereby raising its valence to 4 as illustrated in equation (5).

This 'onium' salt is one of the substrates of the specific enzymes which transfer the methyl group. The second substrate is glycocyamine for the enzyme which synthesizes creatine; it is nicotinamide for the one which forms N-methylnicotinamide. (Because the product, N-methylnicotinamide, is itself a quaternary ammonium salt, it seems probable that the sulphonium compound is at a higher energy-level than the quaternary ammonium salts. The sulphonium compound, during reduction, can thus form a quaternary ammonium compound.) To me, the energy which drives these reactions has a source similar to that involved in the thiaminase reaction. It is the reduction of the sulphonium salt, in which sulphur has a valence of 4, to the divalent condition. In the course of this reaction, creatine or N-methylnicotinamide is synthesized. With such a mechanism in mind, the natural occurrence in cabbage of a related sulphonium salt, namely, methioninemethylsulphonium chloride[15], has added interest.

We may well ask why Nature has troubled herself about this new mode of synthesis and energy transport. Why could she not have made do with the high-energy phosphate compounds alone? A mechanical analogy may help to clarify thinking about this question. Let us liken an organism to a motor-car. This rather elaborate mechanical contraption derives its energy from the controlled combustion of petrol, just as the living organism does by the combustion of carbohydrate. The modern motor-car has this major energy-yielding process rather well controlled. The coupling of the combustion to forms of useful work and to proper production of heat in desirable places has been neatly arranged. Nevertheless, for rather special purposes, for example, for lighting, it has been found much better to convert the energy into electrical forces, and to accumulate these in a storage battery for use when, and exactly when, required. Of course, one could still burn petrol in the headlights; but it is much better to have an electrical system. For ignition, this rather specialized form of energy is vital to the proper functioning of the main energy-yielding process. So also with living organisms, it may be found highly desirable, and possibly vitally important, to have other means of storing and utilizing energy. These oxidation-reduction reactions seem to be one of these specialized processes. The 'onium' compounds

are the storage batteries in which this takes place. Just as in the motor-car, the recharging of these batteries is probably done by a reaction coupled to the main energy-yielding processes.

With this rather crude analogy in mind, let us examine two striking properties of the enzymic reduction of 'onium' salts which organisms may find useful. One is the ionic changes which result, and the other is the extraordinary speed of the reactions. When the quaternary ammonium compounds are converted into tertiary bases, or when sulphonium salts are similarly involved, one starts with a highly ionized but neutral salt, and ends with a weak tertiary base, which at physiological *p*H's is practically non-ionized. This fact arises from the strongly basic properties of quaternary ammonium bases, which are of the same order of basicity as is sodium hydroxide. Simultaneously with the obliteration of this ion, a hydrogen ion appears. The formation of acid, that is, a hydrogen ion, has, in fact, been used to measure both thiaminase[16] and diphosphopyridine nucleotidase[17]. Lorente[18] has recently remarked about similar ionic changes.

In the reduction of either thiamine or diphosphopyridine nucleotide, a relatively large organic ion disappears, and is replaced by a small hydrogen ion. Thus, not only is *p*H-control influenced, but also a more readily diffusible ion (the hydrogen ion) is suddenly formed.

The remarkable speed of the reduction of 'onium' salts warrants comment. Thus, the thiaminase of carp viscera will destroy all the added thiamine (provided the naturally occurring acceptor amines are in excess) in about five minutes[6,7]. The diphosphopyridine nucleotidase of brain is said to destroy an amount of cozymase equal to the dry weight of the brain in an hour[17]. While these great activities could be said to result from an extraordinarily large concentration of the respective enzymes in the tissues, the fractionations which have been carried out show that this is probably not the case. Hence we must conclude that the enzymes act with great speed.

In physiology, at least two processes are known to be associated both with remarkable speed and with the shift of ions. These are the propagation of nerve impulses and the contraction of muscles. Thus, the action potential is associated with, and may even be said to result from, the migration of potassium and sodium ions. The contraction of muscles depends on the migration of calcium and magnesium ions to the contractile substances[19]. One pictures these essential ionic changes as being caused by diffusion. However, recent work[20] has shown that diffusion based on osmotic differentials is much too slow to account for the observed speed of neural and muscular action. It is possible that the disappearance of the organic ion and the generation, on the spot, of the more readily diffusible hydrogen ion, might contribute to the real mechanism. The extraordinarily high speed of the reductions of 'onium' salts would be compatible with such an involvement. Furthermore, the prominent occurrence of 'onium' salts such as acetylcholine, thiamine, and diphosphopyridine nucleotide in nerves, and of carnitine in muscles is suggestive. Creatine, the role of which in muscular contraction has long been ascribed to creatine phosphate, might assume a second role, because, as we have seen, it is synthesized in muscle by an enzyme which acts on the 'active' methionine, a sulphonium salt, with concomitant ionic changes.

There is no real proof that these enzymic processes have anything to do with nerve transmission or muscular contraction. Even if the reduction of 'onium' salts should be found to be of importance in these processes, the actual compounds may be different from those discussed here. Nevertheless, enough circumstantial evidence is at hand to warrant further study.

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OBITUARIES

Prof. T. C. Hodson

Thomas Callan Hodson, who died at his home in Tisbury, Wiltshire, on January 26, aged eighty-one, was born at Hornsey, Middlesex, in December 1871. He was the son of Arthur Hodson, R.N., and Mary Catherine Hodson *née* Callan. The eldest of six children, he went to school at Christ's Hospital, where he became a Grecian, and left in 1890 to go to Queen's College, Oxford, with an Eglesfield scholarship. He took no degree at Oxford, but he competed successfully in 1893 for the Indian Civil Service and in 1894 went via Bengal to Assam. He served in the Khasia and Jaintia Hills, and was for some time personal assistant to the Chief Commissioner of Assam, Sir Henry Cotton. He served later on in the Manipur State, where he was president of the Durbar, but retired from the Service in 1901. He was registrar of East London (now Queen Mary) College during 1903–14; from 1914 until 1920 he served with the British Forces in France, and by 1919 had risen to the rank of colonel, and his services were mentioned in dispatches. During 1921–23 he was principal of Hornsey Rise Training College, and after that he lectured on anthropology in Oxford, London, Cambridge and Michigan, ultimately succeeding Dr. A. C. Haddon as reader in ethnology in Cambridge in 1926.

In 1932 the William Wyse chair of social anthropology was created in Cambridge, and Hodson was the first professor to hold it. He was elected to a

professorial fellowship at St. Catharine's College, where he became a resident fellow and shared with no little satisfaction to himself and to his colleagues in the corporate life of the College. He had been secretary of the Royal Anthropological Institute during 1912–14, and he was later an associate editor of the "Encyclopædia Britannica" (14th edition). He held the Silver Medal of the Royal Society of Arts.

As an anthropologist, Hodson was particularly interested in the linguistic side of his subject, and his first publication was a grammar of the Thado Kuki language (1906). His knowledge of Manipur and the Manipuris enabled him in 1908 to contribute a monograph on "The Meitheis" to the Assam Government's tribal series, which he followed with "The Naga Tribes of Manipur" in 1911. His lectures at the London School of Oriental Studies, delivered in 1922, were published by the Forlong Fund as "The Primitive Culture of India".

Hodson was endowed with intense industry and an unquenchable activity and persistence. As holder of the chair in Cambridge, he set himself unequivocally to popularize the Tripos of Archæology and Anthropology, and succeeded so well that when he retired in 1937 the numbers had gone up from about a dozen to quite four times that number. But it is on account of his own personality that he will be best remembered: decidedly irascible, very intolerant of control or of opposition, he never forgot a kindness shown to him, and all those who followed his varied and rather stormy vicissitudes combined in admiration of his tenacity and fortitude in what were often very difficult circumstances.

In his family life Hodson was extremely happy. His wife and children were as devoted to him as he was to them, and the successes of his children more than made up for the disappointments of the earlier part of his career. J. H. HUTTON

Dr. H. G. Reeves

HARRY GORDON REEVES, senior lecturer in biochemistry in the Medical College of St. Bartholomew's Hospital, London, died on November 22 at the age of fifty-eight, following a recurrence of the severe bronchitis which had caused him considerable discomfort and ill-health in recent winters.

Dr. Reeves's professional career can be divided into two distinct parts. He took his B.Sc. degree with honours in chemistry in 1920 at Birmingham, where he also took the degrees of M.Sc. (1921) and Ph.D. (1924). In the latter year he became a demonstrator in the Physiology Department at King's College, London, and in 1928 he took his D.Sc. degree and became a demonstrator in the Physiology Department at St. Bartholomew's Hospital, a post which entailed heavy and varied teaching duties. Thus Reeves had few further opportunities for doing research; but on the other hand, he acquired a knowledge of all branches of physiology which was to stand him in good stead during his career as a teacher of biochemistry. He made useful contributions to our knowledge of the metabolism of dihydroxyacetone in muscle and other tissues, but it is by his teaching that Gordon Reeves will be remembered.

It was during the second phase of his service at 'Barts', starting in 1936 with his transference to the newly created Department of Biochemistry and Chemistry, that Reeves grew to full stature as a university teacher. Promotion came fairly rapidly. After a short period as demonstrator, he became lecturer and then senior lecturer in biochemistry—a well-deserved recognition of the good work he did during the war-time housing of the Preclinical School at Cambridge and the subsequent period of rehabilitation and expansion in Charterhouse Square.

As a teacher of the fundamentals of biochemistry in relation to medicine, Reeves was first-rate. There is surely a place in academic life for senior teachers of his type, and fortunate is the head of any large department who can call at any time on the services of such a versatile, capable and loyal colleague. Many hundreds of students who have passed through the Preclinical School at 'Barts' have good reason to be grateful to him. His colleagues are the poorer by the loss of a cheerful and ever-willing beloved friend.

A. WORMALL

NEWS and VIEWS

Scientific Research and the Ministry of Supply: Sir Harry Garner, K.B.E., C.B.

AFTER thirty-six years of government service, Sir Harry Garner retires on February 21 from his post as chief scientist of the Ministry of Supply, and will be succeeded by Dr. O. H. Wansbrough-Jones. Sir Harry had intended to become an astronomer; but in 1917 the demolishing of his office during an air-raid necessitated his transfer from the Royal Naval Air Service to the Royal Aircraft Factory (now Establishment), and it was there that, by virtue of his mathematical ability, he became known throughout the aeronautical world for his work on the 'Bristol' fighter aeroplane, in which he made the first measurements ever to be taken in flight on the aerodynamic rotary derivatives of an aircraft. He was the first to develop the fundamental techniques for testing sea-planes and flying-boats and of the hydrodynamics of hull design, and he has always been, and still is, a firm believer in the future of the flying-boat. In 1952 he gave the Wilbur Wright Lecture to the Royal Aeronautical Society, his subject being "Prophecy and Achievement in Aeronautics". Sir Harry has been in turn the chief technical officer of the Marine Experimental Establishment, the Aeroplane and Armament Experimental Establishment and the Airborne Forces Experimental Establishment. In 1942 he was made deputy director of scientific research in the Ministry of Aircraft Production, later becoming principal director of scientific research (air) in the Ministry of Supply, and in 1949 he succeeded Sir Ben Lockspeiser as chief scientist. In this last office he has successfully tackled the difficult problem of building up the scientific staff of the Ministry of Supply, despite the severe shortage of scientific workers, and, though pressed to deploy more effort on applied problems, he has insisted that a proper proportion of the staff should continue to tackle fundamental research problems. He has played a leading part in the extension of the scheme for making promotions to the higher grades in the Ministry solely on the scientific merit of a person's work, and he also introduced a scheme whereby university staff are

employed in Ministry of Supply research establishments during the summer vacation; this has led to a much wider appreciation of the excellent facilities and conditions of employment in the Scientific Civil Service. Sir Harry retires with the good wishes of a very wide circle of friends that he may now have more time to pursue his wide interests and his hobbies, which include oriental ceramics (on which he is writing a book), music, antique furniture and gardening.

Dr. O. H. Wansbrough-Jones, C.B., O.B.E.

Dr. Wansbrough-Jones, who has been appointed chief scientist in the Ministry of Supply in succession to Sir Harry Garner, has been since 1951 principal director of scientific research (defence) in the Ministry of Supply. He was educated at Gresham's School, Holt, and Trinity Hall, Cambridge, of which College he was a Fellow and Senior Tutor at the outbreak of the Second World War. He had earlier been a research student of the Goldsmiths and Salters Companies and a Ramsay Memorial Fellow, and he had studied in Berlin under Prof. F. Haber. Dr. Wansbrough-Jones was a demonstrator in the Department of Colloid Science when he left Cambridge for service in the Army. After serving in many advisory and technical posts, mainly in connexion with chemical warfare, he retired from the Army with the rank of brigadier in 1946, his last appointment being that of director of special weapons and vehicles at the War Office. He was then appointed scientific adviser to the Army Council, a post which his military experience and scientific knowledge enabled him to hold with distinction and marked success. In 1951 he was moved from the War Office to the Ministry of Supply at a time of heavy increase in the activities of the Ministry, and he has held up to the present an important executive post there. This recent experience coupled with his previous work as a scientific adviser have specially fitted him for the post of chief scientist in the Ministry, where his energy, drive and power of application will find full scope.

Dr. W. Cawood, C.B.E.

Dr. W. Cawood takes over on February 23 from Dr. O. H. Wansbrough-Jones (chief scientist designate) the post of principal director of scientific research (defence) in the Ministry of Supply. After graduating in 1929 at the University of Leeds, Dr. Cawood read for his Ph.D. under Prof. R. Whytlaw-Gray, obtaining this degree in 1931 and at the same time winning the Cohen Prize. He then worked in the Chemical Department of the University until 1938, publishing a large number of papers with H. S. Patterson and R. Whytlaw-Gray on the coagulation and other physical properties of aerosols. He also worked with H. S. Patterson on the stoichiometrical determination of the atomic weights of carbon, xenon, nitrogen and fluorine. This work was the first to predict the existence of the carbon-13 isotope. During this period he was appointed a Ramsay Memorial Fellow (1931–33), and also Moseley Scholar of the Royal Society (1933–38). Dr. Cawood joined the Air Ministry in 1938, and during the Second World War worked on air armament, chemical warfare, bomb-sights and fire control. In 1947 he became deputy director of the Royal Aircraft Establishment, and since then he has made a substantial contribution to the Ministry of Supply programmes on guided weapons, conventional air armament and rocket propulsion, for which work he was awarded the C.B.E. this year. Dr. Cawood's many friends will wish him every success in his new appointment.

Volta River Aluminium Scheme

The White Paper on the Volta River Aluminium Scheme (Cmd. 8702) reported the agreement of the Gold Coast Government, the United Kingdom Government and the aluminium producers to set up a Preparatory Commission to follow up the work already done. The Gold Coast Government, with the concurrence of the United Kingdom Government, has now appointed Commander R. G. A. Jackson as special commissioner in charge of the Preparatory Commission. The cost of the Commission will in the first instance be met by the Gold Coast Government, but half the cost will be reimbursed by the United Kingdom Government. It is expected that the work of the Commission will take eighteen months to two years. Commander Jackson was responsible for establishing the Ministry of National Development in Australia in 1950. He was attached to the Pakistan Government early in 1952 for consultation on its development plans, and in the latter part of 1952, at the request of the Indian Minister of Finance, advised the Indian Government and Planning Commission on the implementation of the Indian Five-Year Plan and, in particular, the three major hydro-electric and irrigation schemes.

British Chemical Abstracts

In a written answer in reply to a question from Sir Wavell Wakefield in the House of Commons on February 4, the Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the Council, stated that he understood that the Chemical Council would shortly issue an appeal for funds to enable *British Chemical Abstracts* to continue publication during 1953. He added that the Department of Scientific and Industrial Research has already provided £5,000 to enable the Bureau to continue to operate while the appeal is being made and, provided a satisfactory response is forthcoming from industry, the Government is ready to make a further substantial contribution this year.

Careers in Agricultural Research in Great Britain

A useful pamphlet entitled "Careers in Agricultural Research—Training Grants, Studentships and Fellowships awarded by the Agricultural Research Council, 1953" (pp. 14) has recently been issued by the Agricultural Research Council. There are openings for research workers in many of the twenty-six agricultural research institutes financed by the State. In addition, certain appointments in universities and other research institutions are financed by the Council; many of these are temporary in character, but are particularly attractive to the young worker who wishes to gain experience under the personal guidance of a distinguished man of science. The pamphlet also gives useful information about the scientific staffs of the Council and of the State-aided agricultural research institutes, and about the advisory services. This year the Council is offering for the first time two veterinary clinical fellowships to provide opportunities for suitably qualified veterinary clinicians and pathologists of Ph.D. standing to continue research for two or three years. The fellowships will be renewable annually up to a maximum of three years and will carry a stipend of £850 a year. In addition, the Council is continuing to offer a limited number of junior agricultural

research fellowships, carrying a stipend of £600 a year, to research workers of outstanding ability; and a larger number of postgraduate training grants and research studentships in agricultural and veterinary science. Applications for awards should reach the Council by March 20. Further information and a copy of the pamphlet can be obtained on application to the Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1.

German Meteorological Service of the U.S. Zone

THE former German meteorological service, the Reichswetterdienst, ceased to exist at the end of the Second World War, and separate meteorological services were set up in each of the Occupation Zones in Germany under the auspices of the respective Occupying Powers. A number of publications of the German Meteorological Service of the United States Zone have now been received. They consist of three series, the *Berichte* which report major researches, a minor series entitled *Mitteilungen*, and finally the 'year-books' containing the record of the observations made at meteorological stations in the Zone. The earlier numbers of the *Berichte* are mostly reports of war-time researches. Of these perhaps the most interesting is No. 1, by G. Schulz, which describes the work of the Cloud Investigation Centre, directed during 1940–45 by W. Findeisen. The work included laboratory research, observations in flight, and a theoretical study on sublimation nuclei, ice accretion on aircraft, temperature, humidity and electrical measurements from aircraft, determination of height of cloud top by balloon-borne apparatus, and condensation trails. Findeisen's researches on the critical temperatures for the formation of ice crystals by the condensation of water vapour in the atmosphere are described in this publication. In No. 3, W. Schwerdtfeger applies the observations made in the war-time meteorological reconnaissance flights over the North Sea and Atlantic in a study of the detailed structure of fronts and the relations between temperature distribution in fronts and the cloud and precipitation. Later numbers include an exhaustive description, by H. Hauer, of the weather and climate of the Zugspitze (2,962 m. above mean sea-level) based on the observations made during the fifty years since the famous mountain observatory was opened in 1900, and works on agricultural meteorology by S. Uhlig, N. Weger and W. Baier. As an example of the last class, No. 28 describes the effects of radiation from walls on growth of plants and of the influence of soil coverings of various types, from fine sand to aluminium foil, on the temperature and humidity of the soil and the air immediately above and on plant growth.

Astronomy at Geneva

THE issues during recent years of "Publications de l'Observatoire de Genève" (Série A, Astronomie, Chronométrie, Géophysique; Fasc. 37–43, 1946–52) contain a number of short articles on such matters as seismic disturbances and the behaviour of the pendulums at the Observatory, an approximate solution of the motion of the isochronous pendulum, and the first quartz clock at the Geneva Observatory, illustrated with eight figures. No. 39 contains an article regarding the tercentenary of Newton, in which is reproduced a passage from the address presented by the Helvetian Society of Natural Sciences to the Royal Society; No. 40, "A propos du Centenaire de la Découverte de Neptune", reproduces a number of letters written by Gautier to his parents and also some of the correspondence between Le Verrier and Gautier, which show the close collaboration between them; and in No. 42 Pierre Challande gives a short mathematical analysis of the functioning of a quartz resonator in the neighbourhood of the frequency of resonance, illustrated by ten diagrams, and Dr. R. Luthy deals with the radiotelegraphic reception of the hourly signals. Two other "Publications"—"Résultats des Observations de Chronomètres en 1951" and "Série M, Météorologie" (Fasc. 25)—appeared in 1952; the latter gives a résumé of the meteorological results obtained at Geneva in 1951, first for the whole year and then in tabular form for each month from December 1950 to December 1951.

The Blue-cheeked Bee-eater

A NEW species of bird, the blue-cheeked bee-eater (*Merops superciliosus*), was added to the British list in 1951. Publication of the record was delayed by the editors of *British Birds* since it was felt that the occasion demanded a specially prepared coloured plate. This has now been prepared by Mr. Roger Tory Peterson, and in a recent issue of the journal it is accompanied by details of the first observation of the bird by Miss Hilda M. Quick on the Scilly Isles in June 1951 (*Brit. Birds*, 45, No. 7; July 1952). The bird is about the size of a cuckoo and has a beautiful iridescent green colour with rather darker primaries. There is a dark copper spot on the throat, a black line through the eye, and the forehead and crown are pale blue. The blue-cheeked bee-eater has occurred as a vagrant in France and Sicily, but Europe is outside its normal range, which includes East Africa, Madagascar, north-west Africa, Egypt, Syria, Iraq and Persia, and most of the Oriental region. It would appear that the bird which Miss Quick saw belonged to the Middle Eastern race, although this is not certain.

Studies of a Red Alga

IN a recent paper, Dr. K. M. Drew (*Phytomorph.*, 2, 38; 1952) has compared collections of the common but insufficiently investigated red alga *Bangia fuscopurpurea* from Wales and Naples, by growing them for several generations, under controlled conditions in the laboratory, in a culture solution consisting of filtered sea-water, soil extract and added mineral nutrients. Reproduction has been by asexual spores throughout. Under identical conditions, marked differences, which are described and illustrated, have been consistently observed between the cultures from the two localities. The indications are that further investigations are required to ascertain if *B. fuscopurpurea* is an aggregate species comprising physiological and morphological races. The point is also made that the methods of spore formation in the genus *Bangia* merit re-examination, particularly with reference to the desirability of using the relevant data as a basis of generic distinction in this group.

Persistence of *Rhizoctonia solani* in Soil

THE effects of different living host and other plants, of various mineral additions to soil (sodium nitrate and calcium hydroxide), and of *Trichoderma lignorum*, with and without added corn meal, on the persistence of a heavy artificial inoculation of *R. solani* in the soil, have been investigated under controlled conditions by G. B. Sanford (*Canad. J. Bot.*, 30, 5,

652; 1952). The amount of disease induced in the host plants was found to be the best means of assessing the extent and persistence of the pathogen in the soil. Also, as the experimental results indicate, this organism depends essentially on parasitic nutrition for its propagation and persistence in the soil. *R. solani* disappeared from the soil in some 120 days when various cereals were planted at intervals of 21 days, but was abundant in soils planted with potatoes, beans and peas. The fungus was not suppressed by heavy inoculations with *Trichoderma lignorum* unless the latter was added with corn meal.

A Dominant Sex-linked Mutation in the House Mouse

Although evidence for sex-linked mutations in the mouse has been presented by several investigators, only one of these reports involved a morphological mutation. The results of matings of a new dominant mutation in the mouse, Bent-tail, described by E. D. Garber, suggest that this mutation may be sex-linked (*Science*, 116, No. 3004; 1952). The expression of Bent-tail, in the female, may range from a single almost imperceptible kink to a series of well-defined kinks. In some extreme cases, the tail is bent back on itself and may be pressed against the body. In females, the tail is usually normal in length; in males, however, the tail is usually half the normal length, and the kinks are generally restricted to the end of the tail. Except for the kinks and shortness, the tail is apparently normal. A single Bent-tail male was found in a litter of seven mice resulting from a mating between a normal female of the Namru strain and a bald male. This male, mated with a normal sib, produced Bent-tail females and normal males, suggesting that the mutation was dominant and apparently sex-linked. Two females could not be positively identified as Bent-tail because of the poorly defined single kink. These two females when outcrossed to normal Namru males yielded Bent-tail and normal mice. When the original normal female was out-crossed to a normal Namru male, only normal mice resulted. Finally, the original Bent-tail male was outcrossed to three normal Namru females. These matings also indicated that the mutation was sex-linked and dominant.

A Stain for some Fatty Materials

In a paper in the *Museums Journal* (November 1952), Mr. R. H. Harris, curator in the Museum of Zoology and Comparative Anatomy, University College, London, describes a demonstration which he undertook to define the supporting tissue in the manus of an Indian elephant. A median, sagittal section was prepared so that the cushion of fat and elastic tissue upon which the animal rests its weight could be clearly shown. The dissection was carried out in the fresh state, and, as there was no sharp contrast between the fat, elastic tissue and muscle fibres, it was decided to use a fat stain. This was prepared by adding to a solution composed of equal parts of acetone and 70 per cent alcohol sufficient Sudan III powdered stain to cause saturation. The solution was filtered and kept in a tightly stoppered bottle. Full experimental details are given by Mr. Harris; but the main point is that ultimately only the fat was stained, leaving all other tissues sharply defined. The method renders an anatomical feature in elephants visible for study and research, and the finished dissection provides a valuable museum exhibit.

Hydroelectric Schemes in North Wales

Under the title "Hydro-electricity in North Wales", the North Wales (Hydro-Electricity) Protection Committee has issued a further illustrated pamphlet (pp. 8+4 pl.; from the Committee, 93*a* Scotland Road, Liverpool 3; 1952; 6*d*.), dealing with the six new schemes now proposed for North Wales and involving the areas Nant Ffrancon, Snowden, Upper Conway, Vale of Festiniog, Mawddach, and Plynlimon or Rheidol. The schemes affect the whole of the mountain country from Bangor to Aberystwyth, with the exception of Cader Idris. The Bill to be promoted by the British Electricity Authority is to cover the Plynlimon scheme, the largest, and the Vale of Festiniog. The pamphlet recapitulates the arguments against the schemes and appeals for financial support for preparing petitions against the Bills; the legal expenses involved in fighting such so-called 'private' Bills are heavy, and several thousand pounds is still required for this purpose.

International Meetings in Physics

A number of international meetings in various fields of physics will be held this year, and these will include the following: meeting of the International Optical Commission, at Madrid, April 20–21 (Prof. J. M. Otero, Serrano 121, Madrid); International Congress of Acoustics, in Holland (The Hague, Delft, Eindhoven and Hilversum), June 16–24 (C. W. Kosten, Mijnbouwplein 11, Delft); colloquium on cosmic rays, organized by the University of Toulouse, at Bagnères-de-Bigorre, July 5–11 (Prof. L. Leprince-Ringuet, 17 rue Descartes, Paris 5e); symposium on fundamental theoretical physics and executive meeting of the International Union of Pure and Applied Physics, in Japan (Tokyo and Kyoto), September 15–23, under the presidency of Dr. H. Yukawa (Prof. P. Fleury, Institut d'Optique, 3 Boulevard Pasteur, Paris 15e). Further information can be obtained from the persons named in brackets.

Frank B. Jewett Fellowship Awards

The American Telephone and Telegraph Co. has awarded five Frank B. Jewett fellowships to the following: M. Fixman, a graduate of Washington University, St. Louis, for research at the Massachusetts Institute of Technology on theoretical and experimental aspects of the behaviour of high-polymer molecules in solution, including the statistical mechanics of transport processes particularly involving macromolecules; Dr. H. Helson, a graduate of Harvard University, for the continuation of his work in the Mathematics Department, Yale University, on a clarification of the relations between the Wiener and Kolmogoroff prediction theory and certain questions in analytical function theory which are fundamental to cybernetics and information theory; R. G. Newton, a graduate of the University of Berlin and of Harvard University, for research on the connexion between the quantum field theories and detailed behaviour of nuclei and their effect on surrounding electrons; Dr. R. S. Pierce, a graduate of the California Institute of Technology, for further research on the principles of automatons, clarifying the mathematical fundamentals of how machines can perform near-human operations; and Dr. D. B. Ray, a graduate of Harvard University, for the continuation of his study, up to now conducted at Cornell University, on the essentials of random processes and prediction of events involving atoms and electrons.

These fellowships, which are awarded by a committee from the Bell Telephone Laboratories, are designed to stimulate and assist research in the physical sciences by those who have recently received doctorates or are about to receive them. The stipend is 4,000 dollars to the recipient and 1,500 dollars to the institution at which the research is carried out.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: J. L. Congdon (agricultural officer, Aden), director of agriculture, Aden; R. A. Silverlock (agricultural survey officer, Gold Coast), agricultural officer, Gold Coast; G. M. Stockley (director of geological survey, Tanganyika), director of geological survey, British Guiana; J. H. Hinds (senior agricultural officer, Gold Coast), pasture research officer, Northern Rhodesia; E. A. Lewis (deputy director, East African Tsetse and Trypanosomiasis Research and Reclamation Organization), director of the Organization; M. B. Noel-Buxton (fisheries officer, Gold Coast), senior fisheries officer, Gold Coast; D. McCallum (education officer, Kenya), meteorologist, East Africa High Commission; L. Piening, plant pathologist, Department of Agriculture, Gold Coast; A. M. M. Rees, agricultural economist, Northern Rhodesia; J. P. Scott, agricultural officer, Sierra Leone; T. E. Tomlinson, scientific officer, Sierra Leone; A. W. Reece, geologist, Uganda; L. R. Boulger, pathologist, Nigeria; B. W. H. Stronach, provincial tsetse officer, Tanganyika; Miss R. V. Suter, microbiologist, Microbiological Research Institute, Trinidad; J. W. Wholey, assistant conservator of forests, Nigeria.

Announcements

H.M. THE QUEEN has been graciously pleased to grant Her Royal Patronage to the Institution of Gas Engineers.

THE Hinchley Medal of the British Association of Chemists has been awarded to Dr. Herbert Levinstein, a trustee and past-president of the Association. The presentation will take place in the West Hall of the Royal Society of Medicine, 1 Wimpole Street, London, W.1, on February 27, at 6.30 p.m., and Dr. Levinstein will speak on "Our Changing Chemical Industries: an Appraisement". Prior to the presentation, there will be a brief opening ceremony at the new headquarters of the Association, at Hinchley House, 14 Harley Street, W.1.

DR. W. C. J. ROSS has been appointed to the readership in chemistry tenable at the Institute of Cancer Research (Royal Cancer Hospital), University of London.

AN Easter vacation school in relaxation methods will be held in the Imperial College of Science and Technology, London, during April 9–23. The course will be on the lines of those of previous years and will cover the numerical solution of linear algebraic equations, framework problems, Laplace's and Poisson's equations, the biharmonic equation, eigen-value problems, the heat-conduction equation, three-dimensional relaxation, etc. Lectures will be given in the mornings, and during the afternoons the instruction will consist of solving examples under supervision. The fee for the course is £10. Further information can be obtained from D. N. de G. Allen, Imperial College, London, S.W.7.

A SUMMER school in analytical chemistry, organized by the Royal Institute of Chemistry and the Society of Public Analysts and Other Analytical Chemists and open only to members of these two bodies, will be held in the Royal College of Science and the Royal School of Mines, South Kensington, London, S.W.7, during September 6–12. The course will be divided into three parts, dealing with organic, metallurgical and biochemical analysis, respectively, and there will be one evening meeting on the need for statistical methods in analytical chemistry. The fee for the course is £13 (£3 for the lectures only of any one part); hostel accommodation can be reserved. The course is limited to fifty persons. Further particulars can be obtained from G. Murfitt, at Metals and Methods, Ltd., Bacon Works, Langley, near Slough, Bucks.

THE eighteenth Cold Spring Harbor symposium on quantitative biology will be held during June 5–11, the general subject of the meetings being "Viruses". Emphasis will be on discussion of the quantitative aspects of virus research, particularly research with bacterial viruses, and the following problems will be discussed: virus in the vegetative state and its maturation, pro-virus, transition from pro-virus to vegetative virus, transition from the infective to the vegetative state, structure of viruses, biochemical studies of virus infections, host-controlled variations of viruses, and viruses in tissue culture. Further information can be obtained from the Biological Laboratory, Cold Spring Harbor, New York.

As in former years, a course in tropical hygiene for laymen will be held by the Ross Institute of Tropical Hygiene (forming part of the London School of Hygiene and Tropical Medicine) during July 20–24. The course is for workers in the tropics holding, for example, administrative or executive posts, whose responsibilities entail the health and welfare of others. Morning sessions will be devoted to malaria and its control, and in the afternoons other tropical diseases and problems such as hookworm, bilharzia, nutrition, housing and sanitation, and protection against heat will be dealt with. There is no fee for the course. Further information can be obtained from the Organizing Secretary, Ross Institute of Tropical Hygiene, Keppel Street (Gower Street), London, W.C.1.

THE Institution of British Agricultural Engineers is offering a scholarship for students who experience financial difficulty in completing their studies during the academic year 1953–54 for the final examination of the National Diploma in Agricultural Engineering. The scholarship, which was given last year by the publishers of *Farm Mechanization*, is tenable at one of the colleges approved by the examination board of the Institution, and preference will be given to candidates with engineering qualifications. Application forms (to be completed by May 15) and further particulars can be obtained from the Secretary of the Institution of British Agricultural Engineers, 24 Portland Place, London, W.1.

CAMBRIDGE University Press announces that a list of errata so far discovered in the first edition of "The New Flora of the British Isles" by Clapham, Tutin and Warburg is now available. As most users of "The Flora" will want to transfer the necessary corrections to their copies of the book, the errata slip is being inserted loose in all remaining stock. Booksellers who wish to put the errata slip in their own stock copies, or to supply it to customers who have already bought the book, may have copies free of charge from the Cambridge University Press, Bentley House, 200 Euston Road, London, N.W.1.

SUPPLY OF LABORATORY ANIMALS

A MEETING of representatives of the supporting societies of the Laboratory Animals Bureau of the Medical Research Council Laboratories, Hampstead, was held at the Royal Society of Medicine on January 22, with Dr. R. Lovell in the chair. The purpose of the meeting was to discuss a paper on "The Supply of Laboratory Animals", by Dr. W. Lane-Petter, the director of the Bureau; the paper had been circulated in advance. The Laboratory Animals Bureau has been established for nearly six years, and already it has gathered much useful, and some alarming, information on the sources of the animals used by physiologists, pharmacologists, etc., in their research work or in their work on the standardization of drugs and sera.

Each year the Home Secretary lays before Parliament a "Return of Experiments performed under the Act 39 and 40 Vict., C. 77". Dr. Lane-Petter's paper quotes the figures in the returns for the years 1939–51. They rise steadily from 954,691 for 1939 to 1,919,424 for 1951, and these figures do not include animals which are not returnable under the Act—for example, the control animals where only those of the experimental group are subjected to procedures "calculated to cause pain", most pregnancy-diagnosis tests, and procedures for the production of sera or other substances obtained from animals for medical, veterinary or scientific purposes. An analysis of figures obtained from various sources (inevitably not very accurate) indicates that mice constitute about 79 per cent of the total number of animals used, involving about 43 per cent of the total cost of the animals. The corresponding figures for rats are 8 and 9 per cent, respectively, for guinea pigs 6 and 18 per cent respectively and, at the other end of the table, for monkeys 0·1 and 7 per cent respectively. A table gives the main uses for which the various species are required: applied medicine (diagnosis of disease, pregnancy tests, serum preparation, serum titration, bio-assay and toxicity tests); and research and teaching (physiology, biochemistry, pharmacology, bacteriology and parasitology, endocrinology, nutrition, experimental surgery and teaching). It indicates that research uses the more expensive animals and that applied medicine has adopted the cheaper animals. These are the costs of the animals before being submitted to any experimental procedure. The behaviour of the animals during their laboratory existence has sometimes shown that it is more economical in the end to buy more expensive but really healthy animals than cheaper, less healthy ones. Nearly always home breeding is more expensive than buying from dealers (it would be prohibitive for dogs), and the advantages accruing from such must be weighed against the cost. The commercial breeder probably has lower overhead charges than the scientific breeder, he is probably a better business man and is much more of a specialist in his job. On the other hand, where litter-mate animals are required or animals from parents with a special dietary history, the only absolutely reliable way of obtaining them is by home-breeding; and when mice are required for virus chemotherapy or other virological research, they must be produced under conditions too exacting for commercial breeders.

The procuring of animals which are not specially bred by either a commercial breeder or by the laboratory needing them has some difficulties—for example, monkeys are best imported during the warm months, amphibians are most prolific in the late summer, and guinea pigs are often scarce in the early months of the year. Workers may therefore have to plan to carry out their work when supplies are likely to be good. Heavy demands for the more prolific animals, and especially of young ones, can only be met if orders are placed well beforehand to allow extra matings to be made.

It has been suggested that a general breeding station should be established for the supply of animals to the whole of a university or even to groups of universities. This might or might not have some financial advantage; it would certainly have many disadvantages, for, according to a simple principle of public health, the larger the colony the greater the chance of infection coming in and the less the chance of getting rid of it. Another suggestion which can scarcely be taken seriously is that there should be some centralized depot which would receive animals from all sources and distribute them as needed. The objections to this are the obvious difficulties of controlling the supply and demand, the possibility of infection and the slow adjustment of most animals to change of environment.

On the whole, it appears that most needs can be met from commercial sources and that the acquiring of animals from such sources will be more economical than breeding in the laboratory. It is, however, obviously desirable that some recognized authority should be familiar with the various breeding stations, the strains of animals available and their general condition. It should be able to recommend an alternative source of animals to a worker whose usual source has suddenly become unable to supply his needs. Such a central authority does, in fact, already exist in the Laboratory Animals Bureau. Much has already been done; but much remains to be done to encourage different breeders to produce well-defined strains and perhaps to improve existing strains on the lines used in farm-stock practice for upgrading.

The desirability of using 'inbred' strains of such animals as mice is questioned. The Bureau has discovered that many breeders who claim to supply inbred mice do not, in fact, know the real meaning of the term 'inbred', and, until information based on unquestionable 'inbred' strains is obtained, no reliable conclusion as to their desirability can be drawn. It has also been found that it is practically impossible to keep a colony of animals strictly infection-free, but that a high standard of hygiene will keep a colony healthy enough for most purposes.

To enlarge the supply of cats and dogs, a strong plea is put forward that the humane societies should hand over the really unwanted and ownerless animals that they acquire, for these societies are in a much stronger position than dealers and laboratory workers for ensuring that the cats and dogs which they collect are, in fact, unwanted and ownerless.

The discussion of the paper was opened by Prof. R. E. Glover, representing the Royal College of

Veterinary Surgeons, who approved of the Bureau's scheme of accreditation of breeders but emphasized the dangers of enlarging colonies beyond the limits of the personal care by the owner—for example, the increased danger of infection, and the possibly less careful treatment by subordinate staff. The operation of demand versus supply may be leading to price competition and the consequent annihilation of the smaller breeder whose contribution is useful and often very good. Prof. Glover maintained that cost in research work is indeed watched carefully, but the use of expensive animals as well as the cheaper ones has to be investigated in order to discover the best animal for the purpose in view. Commercial firms benefit by the experience of research workers when they take up large-scale production and test their own products. To overcome the difficulty of having a surplus of young animals at a time of year when they are least wanted, he suggested that a large proportion of these young animals in the glut season should be put to breeding so that the total production in the less good breeding season should, in fact, be increased. He thought that decentralization is distinctly advantageous, but that institutes run by universities on not too large a scale by competent scientific workers would afford a chance of studying animal husbandry and animal diseases; the institutes could train really good technicians, and each institute might specialize in one or two particular species. The linking-up of such institutes would obviously be valuable. Prof. Glover pleaded for more investigations into epidemics in animal colonies, particularly those of commercial breeders. A well-qualified research worker associated with some institute where he would have contact with clinicians, bacteriologists, etc., would be able to do most valuable work on animal epidemics.

Dr. C. C. N. Vass, representing the Physiological Society, emphasized the fact that expenditure on animals must be faced. Often the difficulty in experiments on cats and dogs is to get them of a known age. If this could be done by paying a higher price, it must be paid, and, since such an animal might be under observation for two years, the high price would be justifiable and in fact almost negligible.

Dr. H. J. Parish, representing the Pathological Society, agreed to the need of using healthy animals at almost any cost, particularly for such long-time experiments as are involved in work on prophylactics, which work, it might be stressed, is often done for the benefit of animals and not only for human beings.

Dr. S. J. Folley, representing the Biochemical Society, asked if the possibility of using rats in place of cats and dogs has been considered as carefully as possible; but Dr. Vass replied that, for teaching purposes, the rat is often too small an animal.

In reply, Dr. Lane-Petter said that if breeders' colonies are to be larger, they should be housed in separate small buildings; that prices are becoming stabilized; that putting surplus stock in the summer to breeding purposes would be workable; and that, if institutes for animal breeding should be set up by universities, they cannot be expected to produce all the animals needed. He mentioned again the work of the Bureau in visiting commercial breeders and in giving advice on the healthy running of the colonies.

Great appreciation of Dr. Lane-Petter's paper was expressed, and it was unanimously decided that it should be published *in extenso* or even enlarged, if possible in one of the scientific review journals.

STUDY OF THE BRITISH FLORA DURING 1952

THE discovery, in remote parts of Scotland in recent years, of easily recognized plants such as *Kœnigia islandica* L. and *Diapensia lapponica* L.[1] is sufficient indication that there are still large areas in the British Isles awaiting botanical investigation. During 1952 two more species of northern distribution well known in Scandinavia have been added to our flora.

The finding by Sir Christopher Cox of *Artemisia norvegica* Fr. in north-west Scotland in August has already been announced[2]. Known only from Norway and the northern Urals, it belongs to a circumpolar group of closely related species which are very unlike representatives of the genus previously known from Britain. The other outstanding addition to our list of native species in 1952 is that of a sedge which appears in current Scandinavian literature as *Carex pulchella* (Lönnr.)[3-5]. It is allied to *C. serotina* Mérat (*C. Oederi* auct.), and has been brought to the notice of workers in Britain by Miss E. W. Davies (University College, Leicester). During the summer she found it in several localities in Perthshire and north-west Scotland, and there are specimens in herbaria collected earlier. For reasons of nomenclature she proposes to publish the discovery under an appropriate name which is not the one by which it is known in Scandinavia.

At the annual exhibition meeting of the Botanical Society of the British Isles, arranged in the lecture room of the British Museum (Natural History) (by kind permission of the trustees) on November 29, *Artemisia norvegica* was represented by Norwegian material exhibited by the Department of Botany of the Museum, and *Carex pulchella* by Scottish material in an exhibit prepared by Miss Davies.

Another addition claimed during the year is *Cakile edentula* (Bigel.) Hook. from the coast of north Scotland, the Outer Hebrides and Shetland[6]. Löve has shown that while the British *Cakile maritima* Scop. (which is diploid) ranges around the whole coast of Europe and the Mediterranean, the tetraploid North American *C. edentula* occurs in Iceland and the Azores[7]. D. E. Allen (University of Cambridge) exhibited at the meeting British material determined as representing the two species, with drawings illustrating the characters of the leaves and fruits. A sedge from Ben Lawers which appears to be allied to *Carex parallela* (Læst.) Sommerf.[8] shown by N. Y. Sandwith (Royal Botanic Gardens, Kew), and an unnamed *Euphrasia* from Caithness displayed by Dr. E. F. Warburg (Department of Botany, University of Oxford) may, on further investigation, also prove new. An interesting hybrid between *Rumex conglomeratus* Murray and the naturalized South American *Rumex cuneifolius*, Campd., collected by Dr. F. R. Elliston Wright at Braunton Burrows, North Devon, and shown by J. E. Lousley, is apparently new to science.

The exhibition also included examples of important re-discoveries or extensions of range. One of the most interesting of these was *Ononis reclinata* L. collected last June by Miss H. M. Bigwood on the limestone of the Gower Peninsula. The locality is likely to be the one at which it was found by D. Sharpe on September 18, 1828[9], where, in spite of searches by competent botanists, it has not been seen since that date. The only other stations on the mainland are the well-known one in Devon, and the

Mull of Galloway, where it has not been found for many years. During 1952, *Arenaria norvegica* Gunn. was found by E. C. Wallace on basalt scree in what is only the second station on the mainland—the locality is in the Watsonian vice-county Westerness, 97. He also showed *Draba rupestris* R. Br., *Saxifraga rivularis* L., *S. nivalis* L., *Carex atrata* L. and other rare plants new to west Ross-shire. Miss F. E. Crackles exhibited the scarce grass *Calamagrostis neglecta* (Ehrh.) Gaertn. from Leven Canal, south-east Yorkshire, together with specimens of a putative hybrid with *C. canescens* (Weber) Roth., which grew with it[10]. A surprising extension of range was that of the fern *Dryopteris cristata* (L.) A. Gray from Dungeness, shown with other recent discoveries in Kent by F. Rose (Bedford College, University of London). *Limosella subulata* Ives, previously known only from Glamorgan and the vicinity of Portmadoc, was shown as living material from near Towyn, Merioneth, by Miss C. M. Goodman.

Additions to the list of British plants and to our knowledge of their distribution are of considerable interest; but the intensive studies of species, or groups of species, now being carried out represent work of greater fundamental importance. This work is being furthered by the introduction of new techniques over a wide field. It is a healthy sign that workers are adapting methods used in industry and other branches of science. Two exhibits at the 1952 meeting demonstrated the use of punched cards for statistical investigations. One of these, by P. C. Sylvester-Bradley (Department of Geology, University of Sheffield), illustrated the methods to be used in "The British Rose Survey" which he is organizing in collaboration with Dr. R. Melville. It is intended to enlist the help of a considerable number of assistants to score the characters of bushes in random colonies of roses. The characters are to be recorded on a 'Wilmott grid', and analysed by means of the Powers–Samas system of punched card coding. By this means it is hoped to ascertain the degree of 'reticulation' present.

An ingenious card-index system for ecologists was demonstrated by F. Perring and R. G. West (School of Agriculture, Cambridge). This is an attempt to simplify the task of sorting large quantities of ecological data, and the authors have in mind the possibility of such cards being stored in a national repository. Some thirty-five ecological features of the habitat are recorded by clipping out holes around the edges, while there is space in the centre of the card for listing 715 species of plants. By manipulating the cards it is possible to select all those showing any given combination of ecological factors. Watsonian vice-county numbers are used as part of the reference.

The co-ordination of characters within two 'varieties' of *Lathyrus nissolia* L. was shown by Miss M. J. Herbert and J. M. F. Cannon in an interesting three-dimensional graph-model. Three co-ordinates were employed: mean leaf ratio, pod axial diameter, and pod variation index, and the position on the graph of specimens examined was indicated by beads suspended on threads. Those representing "var. A", with a coloured bead to show the characters of the Linnean type specimen, were separated by a wide gap from those of "var. B", which is var. *pubescens* Beck. A map of the distributions in Europe showed that they occupy separate geographical areas, while living cultures indicated differences in the rate of growth.

Dr. H. G. Baker (Department of Botany, University of Leeds) exhibited *Limonium humile* Mill and *L. vulgare* Mill; these show pollen and stigma dimorphism. The former is monomorphic and self-compatible, and the latter dimorphic and self-incompatible—maps showed the relationship between the British and allied monomorphic and dimorphic species. Mrs. Y. Heslop-Harrison demonstrated variation in *Nymphæa alba* L. Dissections made from material collected in widely scattered localities over the British Isles seemed to indicate that the separation of *N. occidentalis* (Ostenf.) Moss is unjustified. An exhibit by P. T. Yeo (University College, Leicester) of *Euphrasia vigursii* Davey suggested that, while this puzzling plant appears on morphological grounds to be a hybrid between *E. anglica* Pugsl. and *E. micrantha* Rchb., it grows in places where it could not have arisen by direct crossing. O. Buckle and Dr. C. T. Prime illustrated the distribution of *Arum neglectum* (Towns.) Ridley in Sussex with a map and fresh material. Prof. T. G. Tutin (University College, Leicester) exhibited *Poa annua* L., *P. infirma* H.B.K. and *P. supina* Schrad., with hybrids between *P. annua* and the other two species. Of the first species he also showed three genetically different ecotypes which he has in cultivation. A. H. G. Alston (Department of Botany, British Museum (Natural History)) exhibited the hybrid ferns *Asplenium* × *Breynii* Retz. and *A.* × *murbeckii* Doerfl. synthesized from their parents by Dr. Meyer, with specimens found wild for comparison.

During 1952 the first original British Flora[11] for a generation was published, and the influence of this was to be seen in several of the exhibits. Dr. E. F. Warburg (Department of Botany, Oxford), one of the authors, showed some of the little-known segregates described in the Flora. D. E. Greenwood (Botany School, Cambridge) illustrated the distribution of two of these, *Salix cinerea* L. and *S. atrocinerea* Brot., in the Cambridge district with useful observations on the correlation of characters. Miss S. Littleboy showed work on *Galeopsis tetrahit* L. and *G. bifida* Boenn.

Poa palustris L. has been known in Britain since 1879. M. E. D. Poore and Dr. S. M. Walters (Botany School, University of Cambridge) showed maps marked with the stations from which it is known, and considered the evidence for its status. The localities now include Woodwalton Fen, where it is abundant, but unrecorded until 1950, and Wicken Fen, where it has only recently been verified though doubtfully identified material was collected there in 1941. Dr. Walters also had exhibits illustrating the distribution of *Alchemilla minor* Huds. sec. Wilmott, and, with Miss M. E. Bradshaw, the detailed distribution of species of *Alchemilla* in Teesdale. Other exhibits from the Botany School were: *Cardamine hayneana* (Rikli) Junge by D. E. Allen, *Galium pumilum* Murr. by K. M. Goodway, and *Alisma plantago-aquatica* L. and *A. lanceolatum* With. by C. A. Priestley. Further exhibits of small groups included: hybrid carices by Miss E. W. Davies, the affinities of *Catabrosa aquatica* L. by M. Borrill, and *Ranunculus flammula* L. by Miss P. A. Padmore (all of University College, Leicester); autogamous *Epipactis* in Britain and Scandinavia by Dr. D. P. Young, and *Helianthemum canum* (L.) Baumg. by Miss M. E. Griffiths. K. J. F. Park showed some interesting northern species of *Euphrasia*, Dr. A. Melderis (Department of Botany, British Museum (Natural History)) demonstrated hybrids of the

British *Elytrigia*, and G. O. Allen exhibited British charophytes.

An exhibit of considerable general interest, by W. T. Stearn (Department of Botany, British Museum (Natural History)), illustrated "The creation of new species through hybridisation resulting from man's activity". This included the species which have arisen from *Tragopogon pratensis* L. and *T. porrifolius* L., and the well-known *Spartina townsendii* H. and J. Groves. From the European Herbarium of the Museum were shown type-specimens of *Limonium* and *Rubus*, and material of special interest in connexion with recent field meetings of the Botanical Society. The Library of the Museum provided unpublished illustrations of the British Flora by Miss B. O. Corfe, F. H. Round, E. F. Bedford, Miss Margaret Knox and Miss Ellen Hawkins. J. E. Raven, P. D. Sell and Dr. C. West exhibited a series of specimens of little-known British *Hieracia* set out side by side with paintings by Mr. Raven of the same specimens before they were dried. Mrs. H. N. Clokie (Department of Botany, University of Oxford) had an exhibit dealing with Jacob Bobart the elder (1599–1679) and Jacob Bobart the younger (*c.* 1640–1719).

Limitations of space prevent reference to other exhibits, and the selection has been made on the basis of those which indicate the development of our knowledge of the British flora. It is evident that much of the current research is being carried out by younger workers. Many of them wisely restrict their studies to a single species, or to a small group of species, and these are being investigated in greater detail and from more aspects than would have been possible only a few years ago. Scope for the investigation of the British flora is still great. The record of discoveries and progress of research during 1952 is highly satisfactory.

J. E. LOUSLEY

[1] Lousley, J. E., *Nature*, **168**, 934 (1951).
[2] *Gardeners' Chronicle*, **132**, 112 (1952).
[3] Lid, J., "Norsk Flora", second edition, 170 (1952).
[4] Lindman, C. A. M., "Svensk Fanerogamflora", 152 (1926).
[5] Raunkiær, C. (Ed. K. Wilnstedt), "Dansk Ekskursions-Flora", 59 (1942).
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[7] Löve, A. and D., "Studies on the Origin of the Icelandic Flora", **1**, Dept. of Agriculture Reports, Series B, No. 2, 1 (1947).
[8] Sandwith, N. Y., *Watsonia*, **2**, 279 (1952).
[9] Groves, H., and Groves, J., *J. Bot.*, **45**, 280 (1907).
[10] Crackles, E., "The Naturalist for 1952", 183 (1952).
[11] Clapham, R., Tutin, T. G., and Warburg, E. F., "Flora of the British Isles" (1952).

NATIONAL PHYSICAL LABORATORY, TEDDINGTON

ANNUAL REPORT FOR 1951

THE annual report for 1951 of the executive committee of the National Physical Laboratory, Teddington, was presented to the meeting of the general board held on May 23 last and has since been published*. It consists of a general survey of the activities of the Laboratory and its various supervisory committees, together with more detailed individual reports, prepared by the respective superintendents or officers-in-charge, of the work undertaken by the ten Divisions, the Electronics Section and the Test House of the Laboratory.

* Department of Scientific and Industrial Research: National Physical Laboratory. Report for the Year 1951. Pp. 77. (London: H.M.S.O., 1952.) 3*s.* net.

The most important change during the year under review was the transfer of the Engineering Division to the new laboratories of the Mechanical Engineering Research Organization at East Kilbride. Other changes include the closing down of the Statistics Section of the Mathematics Division in order to concentrate on the construction and operation of the Division's two new machines, the ACE (automatic computing engine pilot model) and a 20-integrator differential analyser. No progress was made with the provision of a new ship tank and cavitation tunnel, and the Froude ship research sub-committee has expressed its deep concern at this lack of progress in the provision of what it considers to be equipment essential for the future development of the ship-building industry in Great Britain. An interesting development was the appointment of a small sub-committee to consider the possibilities of the utilization of solar energy.

The report states that, at the extensive series of open days, held during May 23–29, 1951, some 3,400 scientific research workers from universities, government departments and industry were invited to visit the Laboratory. On the two days prior to the meeting of the general board, a symposium on recent developments and techniques in the maintenance of standards was held[1] and the proceedings of this symposium have recently been published[2]. Other meetings held during the year included discussions on the properties of iron, on flaw detection and, with thermometer manufacturers, on the types of thermometers which the Laboratory should undertake to test.

The Laboratory took part in several exhibitions of scientific instruments, including the Royal Society soirées, the Physical Society annual exhibition, and the French scientific instrument exhibition at Paris. During the year an illustrated book, "Jubilee Book of the N.P.L.", describing the past and present work of the Laboratory, was published[3]. Other publications were the first booklet, entitled "Gauging and Measuring Screw Threads", in the series "Notes on Applied Science", and No. 1 in the short series of pamphlets dealing with the units and standards of measurement employed at the Laboratory[4]. The Laboratory has continued to receive many scientific and technical visitors from abroad, and both the director, Dr. E. C. Bullard, and senior members of the staff have paid visits to countries overseas to attend conferences or to exchange information with workers in other organizations. In addition to the names of the members of the general board, executive committee and sub-committees, the report lists the names and positions of the senior staff and includes a bibliography of the numerous scientific papers published by the staff during 1951.

The individual reports of the various sections of the Laboratory make interesting reading. The Aerodynamics Division, mainly concerned with problems connected with the design and performance of high-speed aircraft, reports much work in progress on delta and swept-back types of wings. A new high-speed laboratory was under construction, and two high-speed wind tunnels, one 36 in. by 14 in. and the other 25 in. by 20 in., together with a low-turbulence pressurized wind tunnel (8 ft. by 6½ ft.) were being planned. In the Electricity Division two fresh determinations of the ohm, by reference to the primary standards of mutual inductance and frequency, have been made. These agreed with each other to within one part in 10^6, although they differed from the last set of absolute determinations, made

in 1936, by 15 parts in 10^6. The change is attributed to a possible variation during the past years in the inductance standard. The Light Division has been mainly occupied with the development of the new methods of producing and copying diffraction gratings suggested by Sir Thomas Merton. Flat gratings with a ruled area of 6 in. by 6 in. have been made, and a special lathe, which will enable larger gratings of particular value to astronomers to be produced, was being constructed.

In the Metallurgy Division, investigations on the influence of the interstitially dissolved elements, oxygen and carbon, on the properties of iron, the elastic and plastic deformation of metals, the creep of high-temperature metals and alloys, and the equilibrium diagrams of alloys of titanium and oxygen and of titanium, iron and oxygen, have proceeded successfully. The Ultrasonics Section of the Physics Division has been concerned with the measurement of the elastic constants of solids by dynamic methods and of the absorption of 'Perspex' and 'Catalin' over the range 1–3 Mc./s. The Radiology Section, in order to establish British absolute standards of various radioactive isotopes, has made intercomparisons of measurements and techniques of several organizations, including the Atomic Energy Research Establishment and the Royal Cancer Hospital. Agreement has been reached on some isotopes.

The bulk of the research carried out in the Radio Division has been on wave propagation, and much basic information has been obtained. The study of ionospheric conditions has continued. Semi-conductors have been given special attention, and noise in germanium diodes and triodes, together with an examination of factors affecting the performance of these valves as rectifiers, amplifiers and oscillators, have been the subjects of investigation. Finally, the report records that the volume of work submitted for test in the Test House has increased appreciably, in some instances by as much as 50 per cent, and the sum received annually from test fees has been almost doubled.

[1] See *Nature*, **168**, 594 (1951).
[2] "Rec. Devel. Tech. Main. Stand." (London: H.M.S.O., 1952.)
[3] See *Nature*, **168**, 410 (1951).
[4] See *Nature*, **169**, 267 (1952).

HUMAN RELATIONS IN INDUSTRY

THE scientific study of human relations in industry has been described by Dr. W. H. Scott, of the University of Liverpool, in two issues of the *Journal of the Institute of Personnel Management* (**34**, No. 319; March 1952; and **34**, No. 321; September 1952).

In the first article Scott examines the nature and aims of the work of the industrial sociologist. The industrial sociologist, he suggests, studies the factory as a social system, as a network of relationships between individuals and groups. The most superficial analysis reveals that these relationships are far more complex than the traditional management–worker antithesis suggests. There are the relationships which exist between persons at various levels in the 'line' organization, from the top executive to the charge-hand; between executive and 'staff' personnel; between rank-and-file employees and their immediate supervisors; between managerial personnel and employee representatives; between rank-and-file employees and employee representatives; and between the various persons at a similar level in the organization as, for example, the members of the 'top' management group, the departmental managers, the foremen, or the rank-and-file employees in a particular department.

Although the sociologist may single out one or more of these particular aspects of relationships for detailed study, all are interdependent to some extent. Thus the relationships between employees and their immediate superiors are influenced by the relationships which exist at higher levels in the 'line', and the relationships between higher managerial personnel and employee representatives are determined to a large extent by relationships within the higher management group itself. It is the recognition of this interdependence which is leading sociologists increasingly to insist that any particular problem of relationships within an organization must be studied, and resolved, in terms of the totality of which it forms only a part. Endeavours to change the behaviour of supervisors by the development of more suitable selection and training procedures, for example, will be of limited value unless such endeavours are made as part of a wider plan to change attitudes and behaviour throughout the 'line' organization as a whole. Moreover, the factory does not exist *in vacuo*, and behaviour within its walls is closely associated with the attitudes and relationships which exist in the wider community.

After considering the difficulties confronting those who wish to investigate social relationships in industry, in his second article Scott discusses some of the contributions of current systematic studies by social scientists.

The common beliefs that efficiency and, concomitantly, productivity, necessarily arise out of individual employee satisfaction or high group morale are shown to lack validity. Social scientists are concerned to discover the conditions under which high productivity and high morale are most likely to co-exist, since under such conditions the satisfaction of the needs of both the individual and the organization will be at its greatest. Evidence is increasing that fuller opportunities for self-development and a greater measure of self-determination in industry are the basic pre-requisites. This does not imply the need for more and more joint consultation; rather is it the day-to-day relationships on the job which are crucial in determining morale and attitudes. The pressing need is for the development of leadership ability and skills at all levels. Leadership at the supervisor–employee level should be integrative, seeking to elicit the maximum contribution from each member of the work team by increasing opportunities for participation and self-development, and by ensuring that the feelings and ideas of all are brought to bear on problems and decisions taken. This will not be achieved simply by developing elaborate schemes for the training of supervisors. Consultative leadership must become an accepted administrative practice at all levels.

The importance of a permissive or consultative, rather than an authoritarian, type of leadership in industry is emphasized by the differences between formal and informal social organization, which sociologists have clarified.

Formal organization defines the division of functions among persons or groups of persons and the relationships deemed necessary for their co-ordination.

It never quite works in the manner prescribed, however, owing to the growth of informal relationships which cut across formal lines at all levels.

In some departments supervisors and even employees may approach their manager directly, while in others a rigid observance of the 'channels' may be insisted upon; foremen in different departments may often arrange matters between themselves without 'going through' their respective managers; staff specialists may achieve a position in which they are regarded as executives, although formally they may have a purely advisory status. Other informal relationships are only indirectly connected with the formal organization, such as the groups which arise among employees who work in close proximity to one another or cliques which have a political or religious basis. It would be erroneous to regard this informal organization as unstable or haphazard, for it usually follows a very definite and persistent pattern, and, like all stable relationships, develops characteristic values, norms, beliefs and attitudes which tend to become stereotyped, to be resistant to change, and to be binding on the members of the group. In a real sense, therefore, the informal organization is the one which matters.

In conclusion, Scott suggests that the more the formal and informal organization can be brought into harmony, the more likelihood there is of achieving a system of social relationships which will be effective both in satisfying individual needs and in attaining common goals. T. H. HAWKINS

JOURNAL OF EMBRYOLOGY AND EXPERIMENTAL MORPHOLOGY

GROWTH and change in the needs of scientific publication can often be met by the expansion and alteration of existing learned periodicals, but circumstances may from time to time make the establishment of new journals desirable. In Europe, embryologists, and workers on problems of morphogenesis and developmental change in the adult, have felt the lack of a medium of publication that would both bring together closely related work at present scattered and facilitate the growth of a fruitful co-operation between the many different approaches to the central problems presented by developmental processes.

An attempt to meet this need is being made in the publication of a new quarterly, the *Journal of Embryology and Experimental Morphology*. In founding this journal the original sponsors, a group of British workers in collaboration with Profs. Sven Hörstadius (Uppsala), Chr. P. Raven (Utrecht) and M. W. Woerdeman (Amsterdam) have taken the opportunity of ensuring a fuller measure of international control of its scientific policy than is generally regarded as practicable. The editorial board, which has at present representation from Belgium, Finland, France, Great Britain, Holland, Italy, Sweden and Switzerland, will determine long-term scientific policy as well as giving the editor (M. Abercrombie) active support in carrying it out.

The editorial board met for the first time on January 3 at University College, London. British members were joined by Profs. A. M. Dalcq (Brussels), A. Stefanelli (Rome) and E. C. Wolff (Strasbourg).

Reports from the chairman (Prof. J. Z. Young) and the editor showed that it would be possible to publish four parts in 1953 and that the first issue could be expected during the spring. As was to be expected of an inaugural meeting, a certain amount of discussion centred on problems of a technical and administrative nature; but perhaps the most important discussions were those in which the scientific policy and scope of the journal were defined. There was general agreement that studies on embryogenesis, on regeneration, on growth, and on developmental changes in the older organism as well as on the physiology of fœtal–maternal relations would all fall within the scope of the journal. Parts of other fields, notably sexual endocrinology, the cytology of gametogenesis, and developmental genetics, would, in their ontogenetic aspects, be served. On the other hand, studies in these subjects which were directed primarily to clinical ends, or were otherwise better published in existing journals, would not normally be taken.

Although English will be the usual language of articles in the journal, provision has been made for the acceptance of a number in French and German; and although articles will, for the most part, be reports of original researches, review articles of exceptional value may occasionally be accepted.

The editorial board will meet annually, and it is hoped that its future meetings will not only review the work of the journal but will also be the occasion of the interchange of scientific information. If this happens the journal may well come to serve its field of biology in two of the most important ways open to it: by providing a common public ground in its pages for research into developmental processes; and by encouraging the international exchange of opinion and knowledge through the less formal means of discussions associated with editorial board meetings.

Members of the editorial board are sensible of their indebtedness to the outside bodies who have made the journal possible. In particular, the Company of Biologists, Ltd., which will publish it, and the Clarendon Press, which will produce it, have provided the basis for the whole project, while the British Council has helped to realize one of its most important features, namely, the participation of workers from many countries in the work of the editorial board meeting. D. R. NEWTH

VARIABILITY OF INTERNAL ENVIRONMENT AND THE MECHANISMS OF BIOLOGICAL CORRELATIONS

By EUGÈNE SCHREIDER

Laboratoire d'Anthropologie Physique, 1 rue René Panhard, Paris 13e

IT is generally accepted that internal environment is practically constant. The theory of homeostasis reinforced this old belief, for in its original form it stressed the very narrow limits of biological variations. To-day we can read that in vertebrates even the blood pressure is constant. But variability can now be classified as 'narrow' or 'wide'; we can compare coefficients of variation taken from different biological fields. If we find that they are significantly lower for physiological than for other characters, the relative fixity of internal environment should be

accepted; otherwise it must be rejected as a misleading formula.

Table 1 contains a selection from the data which have been assembled; it mentions also the authors from whose works coefficients of variation (or arithmetical means and standard deviations used for calculating them) were taken.

Table 1

Sources		Coefficients of variation
	Stature	
Schreider, 1950	73 French workers	3·73
,,	75 French soldiers	3·73
,,	100 natives of Indochina	3·18
,,	108 Otomi Indians (Mexico)	2·98
,,	124 Darod (Somaliland)	3·77
	Chest depth	
Schreider, 1950	73 French workers	7·88
,,	74 French soldiers	6·96
,,	100 natives of Indochina	4·91
,,	107 Otomi Indians	6·00
,,	122 Darod	6·20
	Diastolic blood pressure	
Schreider, unpublished	72 French workers	18·26
,, ,,	80 French soldiers	15·98
,, ,,	110 Otomi Indians	11·04
	Heart-rate	
Schreider, unpublished	80 French soldiers (sitting)	14·13
Schreider and Soula, 1951	163 French soldiers (standing)	13·43
,, ,,	163 French soldiers (lying)	16·16
Laugier and others, 1937	130 French workers	14·31
	Respiratory rate	
Whiting, 1915	255 Hungarian soldiers	14·20
Tanner, 1951	46 London students (2 occasions)	17·38–21·33
Schreider, unpublished	65 French soldiers	14·68
	Vital capacity	
Schreider and Soula, 1951	163 French soldiers	15·33
Schreider, 1941	99 natives of Indochina	11·27
,, unpublished	109 Otomi Indians	19·60
	Blood sugar	
Pierce and Scott, 1928	141 healthy men	6·90
Schreider and Soula, 1951	90 French soldiers	9·75
	Serum cholesterol	
Goldstein, 1935	19 American students (3 occasions)	12·60–17·20
Tanner, 1951	46 London students (2 occasions)	15·32–16·02
Schreider and Soula, 1951	163 French soldiers	14·46
	Free serum cholesterol	
Schreider, unpublished	148 healthy young men	26·82
	Hæmoglobin level	
Horneffer, 1928	40 young men	5·41
Schreider, unpublished	157 healthy young men	6·46
	Plasma proteins	
Schreider and Soula, 1951	163 French soldiers	5·79
Goldstein, 1935	19 students (3 occasions):	
,,	*Plasma inorganic phosphorus*	13·50–20·40
,,	*Whole blood creatinine*	11·90–15·50
,,	*Serum calcium*	6·70–10·80
,,	*Serum chlorides*	4·00– 7·20
	Serum Cl^-	
Mme. Leschi, 1951	53 Europeans, Dakar	2·70
,,	79 Negroes, Dakar	2·60
	Serum Na^+	
,,	43 Europeans, Dakar	2·40
,,	46 Negroes, Dakar	3·00
	Serum K^+	
,,	54 Europeans, Dakar	13·10
,,	117 Negroes, Dakar	11·60
	Serum Cu^{++}	
,,	12 Europeans, Dakar	15·10
,,	18 Negroes, Dakar	9·60
	Dogs ($n = 18$):	
Schreider, unpublished	*Serum K*	8·11
,, ,,	*Cerebrospinal fluid K*	12·04
,, ,,	*Serum Ca*	4·84
,, ,,	*Cerebrospinal fluid Ca*	12·95
,, ,,	*Blood sugar*	18·57
,, ,,	*Cerebrospinal fluid sugar*	20·61

Among the anthropometrical data, stature is one of the least and chest-depth one of the most variable. It is clear that, with the exception of serum chloride and sodium, the variability of physiological and biochemical characters is as wide as, and often wider than, the variability of anatomical measurements.

Since in classical works variability is usually expressed in terms of 'limits', it may be useful to point out the following fact. The ratio maximum/minimum value for human stature rarely exceeds 1·25. The same ratio for hydrogen ion concentration in human blood is 1·51. Perhaps we should conclude that body-height is subject to 'infinitesimal variations' only.

There is another, perhaps more important, approach to the same problem. The large inter-individual variability does not mean that intra-individual variation is high. The latter can be tested indirectly by coefficients of reliability calculated between two sets of measurements taken on two successive occasions on the same individuals. The reliability of anthropometrical characters is well known to be very high. The position is very different with many physiological and biochemical characters (Table 2).

Table 2

Sources		Coefficients of reliability (r)
	(*a*) *Human subjects*	
Goldstein, 1935	Cholesterol	0·67
Tanner, 1951	Cholesterol	0·85
Salit and Tuttle, 1944	Heart-rate	0·63
Tanner, 1951	Heart-rate	0·60
,,	Respiratory-rate	0·59
,,	Rectal temperature	0·59
Shock and Yiengst, 1950	Blood *p*H	0·36
Goldstein, 1935	Blood sugar	0·37
,,	Serum calcium	0·15
,,	Blood creatinine	−0·02
,,	Serum chlorides	−0·08
,,	Plasma inorganic phosphorus	−0·16
	(*b*) *Dogs*	
Schreider, unpublished	Blood sugar	0·01
,, ,,	Serum potassium	0·07
,, ,,	Serum calcium	0·29
,, ,,	Cerebrospinal sugar	0·24
,, ,,	Cerebrospinal potassium	0·13
,, ,,	Cerebrospinal calcium	0·06

The serum cholesterol level appears to be one of the most stable biochemical characters. But it is far from 'fixity'. The reliability of other characters is lower, and sometimes the coefficient is zero.

The direct study of intra-individual variability is very difficult because most individuals are unwilling to give a sufficient number of blood samples. Nevertheless, the few data I was able to collect show that for some biochemical characters as many as fifteen to twenty determinations on different days may be needed in order to find a distinct modal value, that is, the value which is really characteristic for a given individual.

It is obvious that the postulate of fixity must be rejected on biometrical grounds. Perhaps this conclusion is distressing for those who put their faith in the 'fixité du milieu intérieur'. But even in the present state of knowledge, it helps us to understand some biological facts.

The lack of correlation between two characters may mean that the intra-individual variability of one of them or both prevents their actual relationship from being detected. On the other hand, intra-individual variability (or low reliability) does not necessarily preclude a character from having obvious correlations. The result of a single determination can be fortuitous; but as there is a mode, there is also a probability that we shall obtain a value more or less characteristic for a given individual. For some characters real correlations must be higher than those actually observed when these are derived from a single determination.

Of course, the lack of correlation can also mean that two characters vary quite independently. We must also become accustomed to the idea that biological correlations are frequently low or non-existent. Survival needs 'elasticity', that is, rather

wide variability of the internal environment; it needs also some physiological decentralization: it seems that, in the course of time, antistochastic mechanisms have evolved, for in many cases perfect correlations would be lethal.

Properly speaking, a living organism contains a score of internal environments more or less separated by 'barriers' the function of which partly consists in lowering and breaking down correlations. The figures of Table 3 illustrate this phenomenon.

TABLE 3 (adult men)

Variates	r
Blood sugar and cerebrospinal sugar ($n = 40$)	0·48
Serum calcium and cerebrospinal calcium ($n = 50$)	0·51
Serum potassium and cerebrospinal potassium ($n = 47$)	0·51

For a single biochemical trait, the 'between environments' correlation is about 0·50. This means that only 25 per cent of cerebrospinal sugar (or potassium, or calcium) variance is tied to the variations of the same character in the blood. These results are very incomplete, but they suggest a most important line of research. Biometry is the study of variation and related phenomena. The biometrician tries to overcome the disorder of things with the help of statistical tools. But first of all, the disorder should be studied as such.

A more complete statistical treatment of all the data assembled, with detailed references concerning the sources of the figures used, will be published later. [July 10.

PREPUPAL MOULT IN THE BLOW-FLY (*CALLIPHORA ERYTHROCEPHALA*)

By DR. P. TATE

Molteno Institute, Cambridge

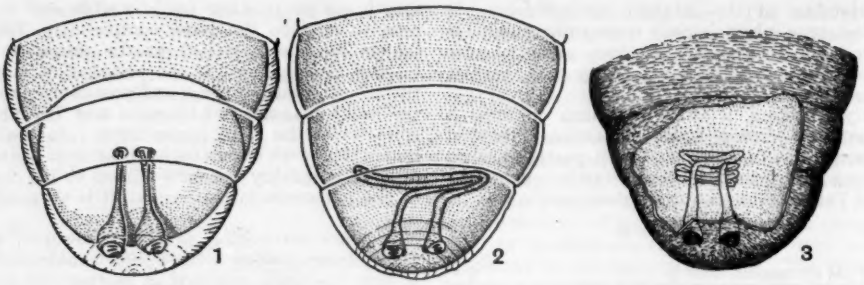
THE occurrence of a fourth, prepupal, moult in cyclorrhaphous dipterous larvæ was first established by Snodgrass[1] for *Rhagoletis pomonella* Walsh. This moult separates the so-called pre-pupa from the true pupa. Fraenkel[2] observed a similar moult within the puparia of *Calliphora*, *Lucilia*, *Phormia* and *Sarcophaga*; but he believed that the prepupal cuticle covered only the abdomen and did not extend forward beyond the line of cleavage between the third thoracic and first abdominal segments of the puparium.

The problem has been re-investigated in puparia of *Calliphora erythrocephala*, which were selected immediately the larvæ had become immobile (white pupæ) and were thereafter incubated in a thermostat at 24° C. to ensure uniform development and to make it possible to obtain the various stages of moulting at will. Under these conditions the fourth moult occurs between 22 and 28 hours from puparial formation. Puparia of the desired age were fixed to microscope slides by cellulose acetate cement and were dissected while alive by slicing off the top of the puparium with a razor blade. The fourth cuticle is extremely delicate; but with care the top half of the puparium can be dissected away to reveal the fourth cuticle enveloping the pupa and separated from the puparium by ecdysial fluid. If the exposed prepupa is flooded with indian ink, or Delafield's hæmatoxylin, the fourth cuticle, which is hydrophilic, takes up the stain, whereas the pupal cuticle is strongly hydrofugal and does not stain. Thus the fourth cuticle is made easily visible and it can be seen to envelop the pupa completely. The fourth cuticle remains attached to the puparium at the lines of cleavage and at the points of attachment of the mouth, anus, anterior and posterior spiracles and the non-functional 3rd thoracic and 7th abdominal spiracles of the third instar larva. In the thoracic region the moult occurs earlier than over the abdomen and, as it quickly becomes affixed to the inner wall of the puparium in this region, it is very difficult to detect.

A more interesting problem, however, and one which does not seem to have been considered hitherto, is how the pupa succeeds in casting the long main tracheal trunks, considering that this fourth moult takes place within the rigid puparium, which would prevent the enclosed pupa from withdrawing the tracheæ in a direct manner. Attempts to solve this problem by observation of the living pupa through 'windows' cut in the puparium were only partially successful; but it was found that if the puparia are coated with mineral oil, or still better, with immersion oil, the puparium becomes sufficiently transparent under intense incident illumination to allow the main features of the fourth ecdysis and, indeed, of the evagination of the head and the extrusion of the pupal respiratory horns, to be followed in the living pupa. Provided the spiracles are not occluded, this treatment with immersion oil does not interfere with the development of the pupa, and flies regularly emerged from coated puparia.

The most easily observed and most interesting part of the process of moulting is that associated with the withdrawal of the posterior part of the main lateral tracheal trunks. The first sign of moulting is the appearance of a bubble of air, surrounding the post-abdominal spiracles, between the pupa and the fourth (prepupal) cuticle. This air bubble enlarges and presses the cuticle against the puparium as the pupal abdomen contracts towards the anterior. During this contraction, which is not uniform but is accompanied by minor movements of contraction and relaxation, the main tracheal trunks are drawn out and extend in an oblique manner from the postero-dorsal surface of the 8th abdominal segment of the pupa to the point of attachment of the post-abdominal spiracles on the puparium (Fig. 1). The contraction reaches its maximum when the posterior end of the pupa is about level with the anterior margin of the 7th abdominal segment of the puparium. This is the maximum withdrawal that can be done by direct contraction, but it leaves much more of the tracheal trunks to be extracted. This phase lasts about an hour. The contracted pupa relaxes and then extends back to the posterior end of the puparium. Meanwhile, the air is transferred to the anterior end by the forward passage of bubbles owing to violent peristaltic contractions of the pupa, and, as it reaches the anterior end, the head is evaginated and the pupal horns are moved back to come beneath the windows in the puparium preparatory to being extruded through them.

The backwards movement of the pupa fills the posterior part of the puparium completely, and, as it does so, the stretched tracheal trunks shorten and are pressed against the inner surface of the postero-dorsal part of the fourth cuticle. Owing to the stickiness of the inner surface of this cuticle, they stick firmly to it whereas they do not adhere to the pupal cuticle, which is smooth and hydrofugal. The pupa then begins to make violent turning and



Figs. 1–3. Dorsal aspect of the three posterior segments of a puparium of *C. erythrocephala* during the fourth, or prepupal moult. The puparium was coated with immersion oil, and Figs. 1–2 show the pupa by transparency through the puparium. In Fig. 3 the dorsal wall of the puparium has been cut away to form a window which is spanned by the fourth cuticle, glued to which are the cast and folded tracheal trunks

Fig. 1 represents the maximum contraction of the pupa and direct withdrawal of the tracheal trunks at 23-hr. incubation at 24° C. Fig. 2, about twenty-five minutes later, shows the posterior parts of the tracheal trunks glued to the fourth cuticle and further lengths of the trunks being pulled out by the sideways writhing movements of the pupa. Fig. 3, about one hour later, shows the fully withdrawn tracheal trunks neatly folded against the inner surface of the fourth cuticle

writhing movements, swaying from side to side in a semi-rotatory manner within the puparium, and, with each lateral movement, a further length of tracheal trunk is drawn out and becomes stuck to the inner surface of the fourth moult to form loops overlapping transversely the portions drawn out by the first contraction which lie longitudinally (Fig. 2). Finally, the trunks are completely withdrawn and remain neatly folded on the inner surface of the fourth cuticle (Fig. 3). Details of the folding and final withdrawal of the tracheæ are difficult to observe as movements during this phase are rapid, and once the tracheæ come in contact with the fourth cuticle, they become wetted, lose their air contents, and are then not easily seen. The final stages can be seen best if the puparium is carefully cut away on the dorsal surface of the last two segments, leaving the fourth cuticle intact. In older puparia this is the only region where the cuticle remains separate from the puparium, and it forms a delicate iridescent membrane stretching obliquely across the postero-dorsal part of the puparium. The lateral abdominal tracheæ are withdrawn and folded in a similar manner by contractions and relaxations of the abdomen; but in them the folds are in line with the axis of the puparium and are not transverse as is the case with the posterior tracheæ.

The characteristic folded arrangement of the tracheæ from the posterior spiracles was noted by Snodgrass[1], who aptly described them as having "the form of a double-stalked T" and further states ". . . but it is difficult to understand how the posterior tubes can acquire their curious arrangement (Pl. 6.E) unless the pupa sways its abdomen sidewise to extract them". As has been shown above, this is in fact what happens in *Calliphora erythrocephala*. It may be noted, however, that in the figure cited by Snodgrass the overlapping of the tracheæ is wrongly shown, as in that figure the wide posterior parts of the tracheæ are shown to be ventral to the thinner, more proximal, parts which emerge last. In fact, it is the wide posterior parts which are withdrawn first and become glued to the fourth cuticle; and the thinner parts are then withdrawn and lie folded beneath, and transversely crossing-over, the wider posterior trunks. The swaying mechanism could not cause the folding to occur in the manner shown in Snodgrass's figure.

The time of onset of the fourth moult, at 24° C., from the so-called 'white pupa' stage is about twenty-two hours, and the whole process may take three hours or more. The first phase, to the maximum contraction of the pupa, takes about one hour; the pressing of the trunks against the cuticle by the backwards movement of the pupal abdomen may take as little as twenty minutes, and the final phase, the swaying of the abdomen and the withdrawal and folding of the remaining part of the tracheal trunks, may be completed in about forty minutes, although sometimes it takes much longer. During the whole of this period of at least several hours, the pupa is undergoing very active and vigorous muscular activity, the abdomen constantly performing contractions and relaxations and twisting and writhing movements. Thus, it is not correct to regard the puparial stage as an entirely quiescent one, as is often assumed in studies on the oxygen uptake of pupæ.

The essential features of the process of casting of the main tracheal trunks during the prepupal moult within the rigid puparium may be summarized as follows. (1) The persisting attachment of the tracheal trunks during the prepupal stage to the posterior spiracles of the puparium. (2) The contraction of the pupa and the appearance of an air space between the pupa and the fourth cuticle, resulting in the direct withdrawal of the first part of the main tracheal trunks. (3) The relaxation of the pupa and its movement backwards to bring the extracted parts of the tracheal trunks in contact with the inner surface of the fourth cuticle. (4) The 'stickiness' of the inner surface of the fourth cuticle, whereby the tracheal trunks become stuck to it when they are pressed against it. (5) The fixing of the cast parts of the tracheæ to the cuticle allows further lengths to be drawn out by the swaying and turning movements of the abdomen of the pupa. These lengths in turn become glued to the cuticle, so that the tracheal trunks are drawn out in relays and become fixed to the inner surface of the fourth cuticle in transverse loops to form a neatly folded mass crossing and recrossing the portions first drawn out which lie longitudinally against the fourth cuticle.

[Nov. 22.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Cephalosporin *N*: a New Type of Penicillin

A SPECIES of *Cephalosporium* has been found to produce two different kinds of antibacterial substance[1,2]. The first consists of a group of acidic antibiotics which are soluble in common organic solvents, are active mainly against Gram-positive organisms[3], and show similarities to helvolic acid[2-4]. The second consists of a substance (or group of substances) which is insoluble in most organic solvents and is active against a number of Gram-positive and Gram-negative organisms. This has been called 'cephalosporin *N*'. Evidence has now been obtained that cephalosporin *N* is a new type of penicillin.

The reasons for believing that the antibiotic is a penicillin are:

(1) It was inactivated by preparations of the enzyme penicillinase in high dilution, and, like benzylpenicillin[5], it stimulated the adaptive production of penicillinase by suspensions of *Bacillus cereus*.

(2) It was rapidly inactivated at room temperature in aqueous solution below *p*H 4 or above *p*H 9, and also at *p*H 7 in the presence of heavy metal ions such as those of copper, lead and tin.

(3) Acid hydrolysis of purified material resulted in the liberation of carbon dioxide. On addition of mercuric chloride to the hydrolysate a mercaptide was precipitated. Decomposition of the latter with hydrogen sulphide and reaction of the product with hot acetone yielded the hydrochloride of *iso*propylidenepenicillamine[6] (2,2-5,5-tetramethylthiazolidine-4-carboxylic acid), melting point 198°, $[\alpha]_D^{20} = +94°$ (found: C, 40·6; H, 7·7; N, 6·0; S, 12·4; Cl, 14·8 per cent; $C_9H_{18}O_2NS,HCl,1/2H_2O$ requires: C, 40·9; H, 7·3; N, 6·0; S, 13·6; Cl, 15·1 per cent). After boiling with dilute hydrochloric acid a solution of the *iso*propylidenepenicillamine hydrochloride showed a strong nitroprusside reaction, and evaporation *in vacuo* yielded the crystalline hydrochloride of penicillamine (β-thiolvaline)[6]. Oxidation of the latter with bromine resulted in the formation of penicillaminic acid (ββ-dimethylcysteic acid).

On addition of 2:4-dinitrophenylhydrazine in 2*N* hydrochloric acid to the supernatant from the mercaptide, only a very low yield of a precipitate consisting of a mixture of 2:4-dinitrophenylhydrazones was obtained. A small proportion of this precipitate was soluble in carbon tetrachloride and crystallized in orange-coloured needles from aqueous ethanol, melting point 183–185° (found: C, 48·2; H, 4·8 per cent). The 2:4-dinitrophenylhydrazone of *iso*butyraldehyde, melting point 182°, requires C, 47·6, H, 4·8 per cent. A further small proportion of the precipitate, which separated in crystalline form from cold pyridine, was glyoxal *bis*-2:4-dinitrophenylhydrazone[6].

The thiazolidine hydrochloride, penicillamine hydrochloride, penicillaminic acid and glyoxal *bis*-2:4-dinitrophenylhydrazone were kindly identified by X-ray powder photographs by Dr. D. Hodgkin, Miss P. Cowan and Dr. J. Robertson.

Cephalosporin *N* differs strikingly from the common penicillins in its hydrophilic character and its antibacterial activity. It behaves like an acidic substance on ion-exchange resins, and ionophoresis on paper shows that it carries a negative charge at *p*H 6–7. However, the purest preparations so far available contain a basic group titrating in the *p*H range 8–11, and the way in which the partition coefficient of the activity varies with *p*H in the phenol–water system indicates that a basic group, as well as acidic groups, may be present in the active substance itself. To explain the fact that the antibiotic is only soluble in highly polar solvents, it would seem necessary to assume that the essential core of the penicillin structure is linked to a residue which is rich in hydroxyl groups and/or contains a basic group which confers a zwitterionic character on the molecule. The nature of this residue is under investigation.

Cephalosporin *N* shows activity of the same order of magnitude against a number of Gram-positive and Gram-negative bacteria. For example, its activity against a strain of *Staph. aureus* is similar to that against a strain of *Salm. typhi*, whereas benzylpenicillin is more than a hundred times as active against the former as against the latter. An attempt has been made to obtain some idea of the purity of the present preparations of cephalosporin *N* by the application of two chemical methods for assaying penicillin[7,8] and by measuring the carbon dioxide evolved on hydrolysis. The results of these procedures agree in indicating that the preparations contain about 35 per cent of active material if the latter has the same molecular weight as sodium benzylpenicillin. Alternatively, they contain nearly 100 per cent of active material if the molecular weight is about 1,000. On the basis of these results, it appears likely that the activity of pure cephalosporin *N* against many Gram-negative bacteria will be of the same order as that of benzylpenicillin. The relatively low activity of the antibiotic against Gram-positive bacteria suggests that it reaches the sensitive part of these organisms much less readily than the other penicillins.

It is of interest that *Cephalosporium salmosynnematin* and certain other members of the genus *Cephalosporium* have been found to produce an antibiotic called 'synnematin', which is active against a number of Gram-positive and Gram-negative bacteria[9,10]. Although no evidence has been published to indicate that synnematin is a penicillin, the data which are available about its physical and chemical properties do not distinguish it from cephalosporin *N*.

We are indebted to the director and staff of the Antibiotics Research Station, Clevedon, Somerset, for the production of cephalosporin *N*.

E. P. ABRAHAM K. CRAWFORD
G. G. F. NEWTON H. S. BURTON
Sir William Dunn School of Pathology,
University of Oxford.

C. W. HALE
Antibiotics Research Station
(Medical Research Council),
Clevedon. Dec. 29.

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A New Antifungal Substance of Fungal Origin

From a mould filtrate we have extracted a new substance with strong antifungal properties. The mould itself, which we were unable to classify completely, belongs to the species *Monosporium bonorden* and has been isolated from a sample of soil from the Belgian Congo. It develops white, almost sterile mycelia on Czapec-agar, with the reverse of the colonies varying from straw-yellow to brown with age.

The best production of active substance is obtained on Czapec–Dox medium after six days at 27° C. Extraction must be carried out by cold chloroform (5 per cent by volume of the filtrate) because the substance loses its activity rapidly when boiled in organic solvents during continuous extraction.

The residue of the chloroform extraction may be recrystallized from chloroform, alcohol or benzene, yielding about 250 mgm./litre of colourless crystals melting at 193·5° C.

By incorporating the active substance into Czapec-agar medium, growth of many moulds was completely inhibited at the following concentrations: at 25 p.p.m., *Penicillium brevi compactum*, *Aspergillus itaconitus* and *Ascochyta pisi*; at 50 p.p.m., *Botrytis cinerea*; and at 100 p.p.m., *Alternaria solani*. The substance shows a pronounced selectivity towards the mould species, for a concentration of 500 p.p.m. was not enough to inhibit the growth of *Penicillium rubrum* Stoll and *Fusarium solani phaseoli*.

By application of the 'slide germination method'[1] spore germination of *Penicillium cyclopium* Westling and *Penicillium stoloniferum* Thom was completely prevented by a concentration as low as 5 p.p.m.

At *p*H 7 the activity is not affected by sterilization for 5 min. at 105° C.

Against bacteria, concentrations of 200, 200 and 1,000 p.p.m. were required to inhibit the growth of, respectively, *Bacillus mycoides*, *T.B.C.* and *Staphylococcus aureus* during 24 hr. at 37° C. Seven other species of bacteria were not affected by concentrations up to 4,000 p.p.m. The substance is optically active, $[\alpha]_D^{20} = +203°$ in chloroform, and contains only carbon, hydrogen and oxygen. Molecular weight determinations gave, by different methods: 323, 332 and 337. Semimicro analyses gave: C, 60·40 and 60·41 per cent; and H, 4·81 and 4·75 per cent, leading to the empirical formula $C_{17}H_{18}O_7$.

The presence has been detected of two phenolic hydroxyl groups, one active hydrogen on an aromatic ring, one double link in a side-chain and a free carboxyl group. Ferric chloride produces a violet colour. The substance is almost insoluble in water but dissolves readily in dilute alkalis giving a yellow solution.

Acetylation and benzoylation give, respectively, a diacetate of melting point 189° C. and a dibenzoate of melting point 215° C., neither of which showed antifungal properties. Linking the substance with diazosulphanilic acid gives a brick-red pigment of melting point 123° C. with the same antifungal properties as the original substance. Oxidation with alkaline potassium permanganate breaks up the molecule, and one of the products isolated has been identified as succinic acid.

The analyses and chemical properties of the new antifungal substance we have isolated indicate that its molecular structure may be closely related to the structure proposed for mycophenolic acid[2], an antibiotic extracted from *Penicillium brevi compactum*[3]. Further experiments are being carried out to confirm this relationship.

P. Delmotte
J. Delmotte-Plaquee

Section of Biochemistry,
Laboratory for Chemical Research,
Ministry of the Colonies,
Tervuren, Belgium.
Aug. 4.

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Ribose and the Maillard Reaction in Fish Muscle

The occurrence and control of the Maillard reaction has been studied fairly thoroughly in dehydrated milk, eggs, fruits and vegetables; but little information is available concerning its prevalence in flesh foods. It has been shown in previous work that moist fish flesh usually becomes brown during exposure to high temperatures (for example, 120° C. for 1 hr.), and that this alteration is due to reactions of the Maillard type[1]. The nature of the sugar or substance contributing the aldehyde groups essential for these reactions was not ascertained. The present investigation indicates that ribose is responsible.

It was found convenient to determine the relative intensity of browning in heated muscle of white-fleshed fish by use of a Beckman model *DU* spectrophotometer equipped with a reflectance accessory attachment. As an arbitrary standard a 'white' surface made by blending 4 per cent high-viscosity carboxymethylcellulose and 2·5 per cent magnesium carbonate with water was used. The percentage of light reflected from the surface of heated fish samples was referred to this standard set as 100 per cent, a wave-length of 500 mμ being used.

It was found initially that the muscle of the sea fish examined had a total pentose content which often exceeded 1,500 μgm. per gm. of wet weight. This is probably associated with, or derived from, the nucleic acid of fish muscle nucleotropomyosin[2]. Since tests[3] of aqueous extracts of the muscle for deoxyribonucleic acid were negative, it was reasonably certain that deoxyribose was absent, thus verifying other work[3].

For comparative studies, muscle of halibut (*Hippoglossus stenolepis*), which browns very slightly on heating at 120° C. for 1 hr., was compared with that of lingcod (*Ophiodon elongatus*), which, in common with local species of flounders and *Sebastodes*, browns markedly on heating. With lingcod muscle, total pentose, as determined using a trichloracetic acid extract[2], decreased considerably after heating for 1 hr. at 120° C.; but there was no appreciable further loss after an additional 2-hr. heating. On the other hand, with halibut there was very little measurable loss of total pentose even after heating for 3 hr. When 1,000 μgm. of D-ribose was added per gm. of either halibut or lingcod muscle, it could no longer be recovered from the heated flesh. These findings indicated that only free and not combined pentose was inactivated in heated muscle. In addition, it was found that the ribosides guanosine, uridine and adenosine did not occasion an increase in browning of heated muscle as did ribose itself.

Preliminary attempts to show that free ribose was responsible for browning in heated muscle were not successful, for only small amounts of ribose were found in extracts of muscle which had been dried *in vacuo* over sulphuric acid overnight. Apparently, most of the ribose combines with free amino groups during the brief drying period, and can no longer be extracted. Extracts of the muscle prepared as follows gave a satisfactory recovery of ribose. Fresh or thawed muscle was blended with 9 volumes of absolute ethanol for 1 min., and 30 ml. of the clear filtrate from the alcoholic extract was concentrated to dryness over sulphuric acid *in vacuo*. The residue, which contained lipoidal matter, was mixed with 1 ml. of water, and the solution applied directly to 28-cm. wide sheets of Whatman No. 1 filter paper for chromatographic separation of the ribose. It appeared that fairly satisfactory chromatographic separation could be effected without desalting the solutions.

In quantitative experiments it was found convenient to apply eight 0·02-ml. spots (in successive applications) of the above extracts at 2·5-cm. intervals along the starting line, qualitative control spots of ribose (5–20 μgm.) or muscle extract being placed near the edges of the paper as qualitative 'markers'. Recovery experiments with D-ribose alone and D-ribose plus the lingcod extract were also carried out. The papers were equilibrated and developed for 16 hr. at room temperature with ethyl acetate – acetic acid – water solvent[4]. After evaporation of the solvent at room temperature, the position of the ribosides present was determined by irradiating the chromatograms with ultra-violet light and marking the dark areas with pencil. It is essential that this be done, so that ribosides, which naturally interfere with the pentose determination, are not cut out with the strip used for determining ribose. Strips containing the 'markers' were cut from along the edges of the chromatograms and the location of the ribose ascertained by spraying with aniline oxalate[5] reagent. This qualitative development always gave very pronounced coloured spots with the lingcod extracts and only very faint spots with those of halibut. To determine the ribose quantitatively, strips 5 cm. wide were cut across the papers to include all the zones corresponding to D-ribose, a similar control strip being cut from another area of the paper which contained no riboside zones. The strips were eluted with 16 ml. of water, the solutions passed through ultra-fine 'Pyrex' sintered-glass filters to remove small particles of filter paper, and ribose determined by Mejbaum's method[6] using duplicate 1-, 2- and 3-ml. portions. The results of a typical experiment are given in the accompanying table, all figures being calculated on the basis of the wet muscle. It will be seen that the amount of ribose which was recovered from the unheated alcoholic muscle extracts after chromatographic separation corresponds closely with that which disappeared when the muscle was heated for 1 hr. at 120° C. The recoveries of chromatographed D-ribose, and of D-ribose plus lingcod muscle extract, were good.

Though so far D-ribose has not been identified positively by isolation and chemical characterization, it has been observed that only a single spot can be developed when mixed lingcod extract and D-ribose are chromatographed together.

FREE RIBOSE IN HALIBUT AND LINGCOD MUSCLE AND ITS RELATION TO THE BROWNING OF THE HEATED MUSCLE (HEATED HALIBUT MUSCLE = 64 PER CENT REFLECTANCE AND HEATED LINGCOD MUSCLE = 36 PER CENT REFLECTANCE AT 500 mμ)

Material chromatographed	Total muscle ribose (μgm./gm.)	Total muscle ribose after heating 1 hr. at 120° C.	Loss of ribose due to heating (μgm./gm.)	Ribose recovered after chromatographic separation (μgm.)
Halibut muscle extract (0·16 ml. = 0·48 gm. muscle)	1580 1540 1560	1530 1526 1528	32	40 31 35·5
Lingcod muscle extract (0·16 ml. = 0·48 gm. muscle)	1460 1406 1433	850 830 840	593	585 525 555
180 μgm. of D-ribose				186 191 188·5
80 μgm. of D-ribose plus 133 μgm. (expected) ribose in lingcod muscle extract*				220 (213 expected)

* Calculated from the average ribose content of the lingcod muscle as given in this table.

H. L. A. TARR

Pacific Fisheries Experimental Station,
Vancouver 2, B.C.
Aug. 6.

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Myoglobin from Carp Muscle

THE occurrence of myoglobin in fish muscle has been postulated by several authors[1,2]; but no clear evidence for it has been given so far. A red muscular region made of cells rich in sarcoplasm[3] exists, however, in many teleosts underneath the skin; its width is greatest at the level of the lateral line and decreases progressively dorsally and ventrally[4] (Musculus lateralis superficialis Trunci).

Our experiments were carried out with the muscles of these lateral red bands from the carp (*Cyprinus carpio*). The muscles are removed and kept frozen at − 20° C. Before extraction, they are cut into slices 40 μ thick with an automatic freezing microtome and extracted twice for 1 hr. in the cold with 1 vol. water. The turbid reddish extract is easily clarified by dialysis against water and centrifugation; a clear cherry-red solution is obtained which contains all the coloured material of the extract. Electrophoretic analysis of this solution reveals that the red colour migrates as a single peak with a mobility of $-2{\cdot}5\ (\pm 0{\cdot}05) \times 10^{-5}$ cm.^{2}/V./sec. at ionic strength 0·15 (0·1 sodium phosphate and 0·05 sodium chloride) and *p*H 7·3. Addition of carp hæmoglobin to a similar extract prepared from white carp muscles shows that the hæmoglobin migrates much more slowly, with half the mobility of the coloured peak of the red muscles. The occurrence in our extracts of a carotenoid rendered water-soluble by attachment to a protein is unlikely; no such complexes appear to exist in fish[5]. It has been suggested by Banks[6] and Bechtold[7] on the basis of preliminary spectroscopic investigations that the cytochrome

content of the lateral bands of herring and cod would be particularly high; but the gradient observed cannot correspond to cytochrome *c*, which has an isoelectric point of about 10 (Tint and Reiss[8]). It thus appears that we are dealing with myoglobin.

This identification has been confirmed by the use of Theorell's[9] isolation method. Fish myogen and globulin X are removed at 30° C. from the turbid extract previously mentioned by addition of 0·15 vol. of *M*/2 basic lead acetate, and the excess of lead is removed by solid tertiary phosphate, the *p*H being kept throughout between 7 and 8 by suitable addition of *N* sodium hydroxide or *N* acetic acid. The ionic strength is then increased by addition of a saturated neutral ammonium sulphate solution to a value corresponding to 75 per cent saturation. The amount of coloured material removed at this salt concentration is small. Solid ammonium sulphate is then added up to 95 per cent saturation. The red precipitate obtained is dissolved in water and dialysed against the buffer of ionic strength 0·15 and *p*H 7·3 previously mentioned. Electrophoretic analysis of these preparations reveals the presence of two gradients, the faster coloured one representing about 30 per cent of the total protein concentration. A similar separation is obtained in the ultracentrifuge, the slow-moving peak corresponding to a chromoprotein of a corrected rate of sedimentation of $1 \cdot 7$–$1 \cdot 8 \times 10^{-13}$. A preliminary examination of the visible spectra of these preparations gives three maxima of absorption, one very pronounced at 415 mμ and two much smaller ones at 540 and 575 mμ, in good agreement with the previous determinations of Theorell[10] and others[1] on myoglobin.

Carp myoglobin sediments therefore at approximately the rate of horse, ox and cat myoglobins[11]. Its electrophoretic mobility, however, is very different from that of horse[9] and whale[12] myoglobins and is similar to that of rabbit myoglobin[13], so far as we can judge from the very different experimental conditions used. Its electrophoretic behaviour thus agrees well with the well-known heterogeneity in amino-acid composition of the myoglobins, and its ultracentrifugal behaviour with their apparent similarity in size and shape. From the point of view of comparative biochemistry, it appears also to be widely distributed among fishes, in view of the frequent occurrence of the lateral bands in these primitive vertebrates[4].

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G. Hamoir

Laboratory of General Biology,
University, Liège.
Nov. 5.

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Structure of the Nucleic Acids

We have formulated a structure for the nucleic acids which is compatible with the main features of the X-ray diagram and with the general principles of molecular structure, and which accounts satisfactorily for some of the chemical properties of the substances. The structure involves three intertwined helical polynucleotide chains. Each chain, which is formed by phosphate di-ester groups and linking β-D-ribofuranose or β-D-deoxyribofuranose residues with 3′, 5′ linkages, has approximately twenty-four nucleotide residues in seven turns of the helix. The helixes have the sense of a right-handed screw. The phosphate groups are closely packed about the axis of the molecule, with the pentose residues surrounding them, and the purine and pyrimidine groups projecting radially, their planes being approximately perpendicular to the molecular axis. The operation that converts one residue to the next residue in the polynucleotide chain is rotation by about 105° and translation by 3·4 A.

A detailed description of the structure is appearing in the February 1953 issue of the *Proceedings of the National Academy of Sciences of the United States of America*.

Linus Pauling
Robert B. Corey

Gates and Crellin Laboratories of Chemistry,
California Institute of Technology,
Pasadena 4, California.
Jan. 2.

Non-specific Precipitation of Proteins by Polyhaptenic Dyes

The proteins bovine γ-globulin and human serum albumin were found to give precipitates with the polyhaptenic dyes, 2-methyl-4,6-di(*p*-azobenzenearsonic acid) phenol (III), and 1,3-dihydroxy-2,4,6-tri(*p*-azobenzenearsonic acid) benzene (VI)[1], from *p*H 3·72 to *p*H 0·2–0·3 above the isoelectric points of the proteins, and in sodium acetate – acetic acid buffer of ionic strength either 0·20 or 0·10. Either 0·5 or 1·0 ml. protein solution was added to 0·5 or 1·0 ml. of each of a series of serially diluted dye solutions of initial concentrations of 0·57 (III) and 0·80 per cent (VI), the serial dilutions being made with buffer of the same *p*H and ionic strength as the protein solution.

In general, the amount of protein precipitated in each experiment increased to a maximum in the second or third—occasionally the fourth or fifth—of the eight tubes in the serial dilution. This suggests that the precipitation is due to the formation of a framework, as in the case of serological precipitation, particularly those in which the precipitating antigen is a simple substance[1].

On the assumptions that at *p*H 5·5–5·7 the dyes combine with the proteins as monomeric molecules, and that the haptenic groups interact with separate combining groups of the proteins, the number of combining groups per γ-globulin is calculated to be 44 for compound III and 36 for compound VI. Similarly, a value of 22 was estimated for albumin with compound III.

Further, it was found that at *p*H values from 5·0 to 5·4 at which neither compounds III nor VI produces a precipitate with albumin, the presence of albumin dramatically decreases the amount of pre-

cipitation of these compounds and γ-globulin. Apparently the albumin forms soluble complexes with either or both the dye and the γ-globulin.

These results are of interest in connexion with attempts to manufacture antibodies *in vitro*[2], and also with the observation that the reaction of polyhaptenic substances with purified hapten-homologous antibody is considerably different from that of these substances with antiserum[3].

This work was initiated in the laboratory of Prof. Linus Pauling, California Institute of Technology, whom I wish to thank for his assistance. A complete account of the work will be published elsewhere.

JOHN L. MORRISON

Department of Chemistry,
University of Alberta,
Edmonton, Alberta.
July 25.

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Influence of Temperature and Iron on Hæmoglobin Synthesis by *Daphnia*

Daphnia, in common with other branchiopod Crustacea, synthesizes hæmoglobin in response to a deficiency of dissolved oxygen in the surrounding water[1]. The hæmoglobin is in solution in the blood. In poikilothermal animals, chemical processes in the body normally proceed more rapidly at a high external temperature, and we have found that in *Daphnia* hæmoglobin synthesis is quicker in warm water. We wished, in addition, to know whether, at the lower of two temperatures, *Daphnia* would eventually acquire as much hæmoglobin as at the higher temperature (the low oxygen contents of the waters being maintained at the same level) or whether at the higher temperature a greater amount of hæmoglobin would be synthesized. The second alternative proved to be correct. In one experiment with *D. obtusa*, in water containing approximately 1 ml. dissolved oxygen per litre, the hæmoglobin content of the blood increased, in 28 days, five-fold at 17° C. but seven-fold at 28° C. After that there was no further increase. One cause of the greater synthesis at the higher temperature is probably the low oxygen content of the tissues, due to a high metabolic rate.

There are great differences in the iron content of natural fresh waters in which *Daphnia* lives. It has been found to vary between 50 mgm./l. and no iron detectable by dipyridyl (before or after reducing). The question thus arises as to whether the addition of iron salts to water containing little, or no, detectable iron would increase the quantity of hæmoglobin synthesized by *Daphnia* in response to oxygen deficiency. Our work has shown this to be the case. In one experiment, at 20° C., in water with no detectable iron and a low dissolved oxygen content of 0·9 ml./l., the blood hæmoglobin increased seven-fold in sixteen days (deriving its iron no doubt from algal food) and then remained steady for a further twelve days; whereas in similar water, to which 4 mgm./l. iron was added every other day, the increase in sixteen days was between nine-fold and ten-fold, with subsequent maintenance of this level for twelve days.

It was found that ferrous salts are more effective than ferric salts in augmenting hæmoglobin synthesis. This is curious for the following reason. A hæmochromogen is present in the gut lumen of *Daphnia*[2]. At the low oxygen content of the outside water necessary for hæmoglobin synthesis by *Daphnia*, this hæmochromogen can be seen with a spectroscope to be in the reduced state, the α-absorption band showing clearly. Now, the redox potential for the reduction of various hæmochromogens is known to be well below that at which the ferric ion is reduced to the ferrous state[3]. It is thus probable that in the gut lumen of *Daphnia* iron is in the ferrous state, even if swallowed as a ferric salt. The explanation of the greater effect of ferrous salts in increasing hæmoglobin synthesis seems to be as follows. The ferric salt added to the experimental water is gradually converted to ferric hydroxide and precipitated. The ferrous salt is also converted to ferric hydroxide, but in a more finely divided state which remains longer in suspension, and is thus available to *Daphnia* for a longer time.

A full account of these results will appear in the *Proceedings of the Royal Society*.

H. MUNRO FOX
ELIZABETH A. PHEAR
BARBARA M. GILCHRIST

Bedford College,
University of London.
Dec. 17.

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Role of Choline in the Oxidation of Fatty Acids by the Isolated Liver

THE lipotropic effect of choline has been interpreted most generally by assuming that fatty acids are carried out of the liver in the form of plasma phospholipides. However, the role of these compounds in the transport of fatty acids has been questioned[1]. The results presented here strongly suggest that choline acts by enhancing the oxidation of fatty acids in the liver.

In each experiment, slices or homogenates were prepared simultaneously from the liver of rats previously maintained on different diets, namely, (*A*) a choline-deficient diet (diet 26, containing 5 per cent casein[2] with added guanidoacetic acid 1 per cent), (*B*) a choline-supplemented diet (diet 26, with added choline-hydrochloride 0·4 per cent), or (*C*) a stock diet. In most experiments one or two animals received also 0·1 millimole of choline-hydrochloride, given in two intramuscular injections, 1·5 and 0·5 hr. before the rats were killed. The slices or homogenates were incubated with 1-^{14}C sodium stearate (obtained from U.S. Testing Co., Hoboken, N.J., on allocation from the U.S. Atomic Energy Commission) in a medium of Ringer-phosphate without calcium or magnesium[3]. Control flasks containing the same amounts of materials were kept at 100° for 10 min. before the addition of the isotopic stearate and then incubated. The carbon dioxide produced during the incubation was trapped in sodium hydroxide, precipitated as barium carbonate, and its radioactivity determined with a Q gas-flow counter. Total lipides, lipide phosphorus, and total nitrogen were determined on separate samples of the liver.

Carbon Dioxide Production from 1-^{14}C-Stearate

Exper. No. (and days on diet)	Preparation	Diet	Liver fat* (mgm./gm.)	Carbon-14 dioxide (counts per min.)†	
				1 gm. moist tissue	Whole liver of a 100-gm. rat
11 (9)	Slices‡	Choline-def.	83	1,985	8,340
		Choline-def.††	148	4,370	18,400
		Choline supp.	30	3,413	13,400
16 (17)	Slices‡	Choline-def.	204	396	1,720
		Choline supp.††	27	2,600	12,100
		Stock	26	1,754	6,450
9 (24)	Slices‡	Choline-def.	260	539	2,480
		Choline-def.††	135	1,440	10,250
		Choline supp.	28	1,062	4,650
15 (28)	Homogenate‖	Choline-def.	166	278	1,520
		Choline-def.††	152	1,404	7,750

* Liver fat = total lipides, less total phospholipides (lipide phosphorus × 25).

† Each value is the average of 3–4 determinations on separate flasks, and has been corrected for the radioactivity in the control flasks.

‡ Liver slices (0·5–0·7 gm.) in Ringer-phosphate without calcium or magnesium (*p*H 7·4), incubated in air for 3 hr. at 37° (Warburg water-bath). Additions: 1-^{14}C sodium stearate (1–1·5 μM, 2–3 × 10^5 c.p.m.), penicillin and streptomycin (3 mgm. each). Total volume: 6–7 ml.

†† Rats injected with choline-hydrochloride (0·05 mM), 1·5 hr. and 0·5 hr. before death.

‖ 0·8 liver homogenized (1 : 5) in Ringer-phosphate without calcium or magnesium (*p*H 7·4). Additions: 1-^{14}C stearate (1 micromole, 2·0 × 10^5 c.p.m.), adenosine triphosphate (2 × 10^3 mM), penicillin and streptomycin 3 mgm. each. Total volume: 6·5 ml.; 3 hr. incubation in air.

The results of a few representative experiments are reported in the accompanying table. Liver slices from rats on choline-deficient diet produced less carbon-14 dioxide than those from rats on the stock diet. Supplementation of the deficient diet with choline raised the values of the isotopic carbon dioxide. Differences in the amounts of isotopic acetoacetate paralleled those described for the production of carbon-14 dioxide.

The most marked and consistent increases were observed in the livers of rats injected with choline shortly before death. It may be suggested that a high rate of production of carbon-14 dioxide by the isolated tissue is dependent upon a certain level of choline (or of a choline derivative) at the beginning of the experiment, and that ingestion of a diet containing choline does not maintain at all times such optimum level in the liver cells, possibly because of a rapid destruction of the active factor. This would be consistent with the well-known rapid disappearance of choline introduced in the body. The possibility should perhaps be considered that, in the liver of choline-deficient animals, the isotopic stearate might have been diluted by the large amounts of fat accumulating in the tissue, with a consequent lowering of the specific activity of the stearate at the site of its oxidation. However, the lack of a quantitative inverse relationship between the fat content of the liver and the production of carbon-14 dioxide is not in favour of such a possibility. Furthermore, from the similarity of the results obtained in the experiments with slices and homogenates, it would appear that the action of choline cannot be explained simply by an increase in permeability of the cell membrane, and more probably consists of a stimulation of fatty acid oxidation in the isolated liver. Since *in vitro* addition of choline (in concentrations 0·003–0·015 M) was not effective, it is suggested that the active factor is not choline, but some substance formed from choline *in vivo*[4].

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Camillo Artom

Department of Biochemistry,
Bowman Gray School of Medicine,
Winston-Salem,
North Carolina.
July 7.

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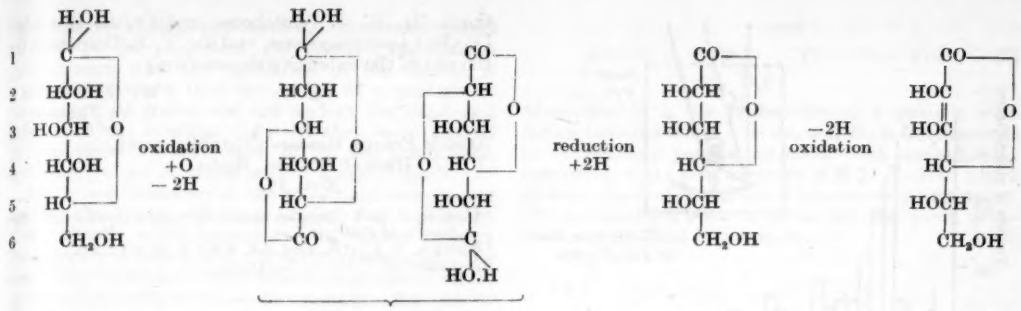
Synthesis of L-Ascorbic Acid in Plants and Animals

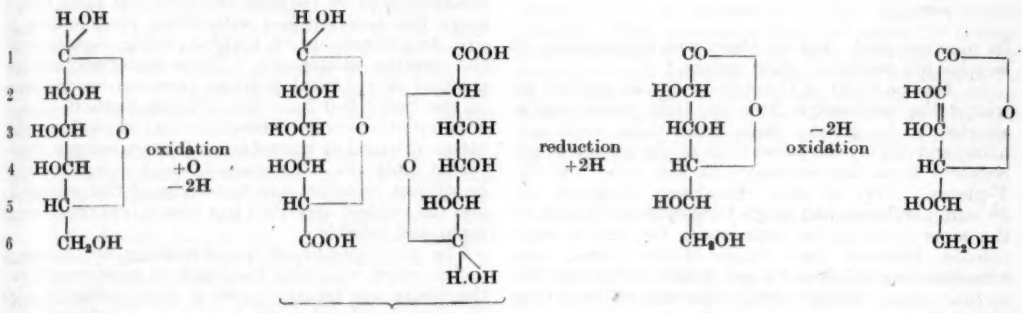
Studies in this laboratory have yielded evidence with both plants and animals that the conversion of D-glucose to L-ascorbic acid is by way of D-glucuronic acid and L-gulonic acid (or derivatives), and it seems that D-galactose may also pass to L-ascorbic acid through corresponding intermediates. The overall conversion of sugars (D-glucose, D-fructose and D-mannose) into L-ascorbic acid had, of course, been demonstrated previously, by Ray[1] and others in plants, and by Jackel, Mosbach, Burns and King[2] in animals.

The experimental facts are as follows. The γ-lactones of D-glucuronic acid and L-gulonic acid, when fed to cress seedlings or injected into rats, were found to be transformed into L-ascorbic acid. D-Galacturonic acid methyl ester, and L-galactonic acid γ-lactone behaved similarly. No other sugar acid γ-lactone yielded L-ascorbic acid when tested in the same way, although all the sugar acid γ-lactones, both D- and L-, were examined except those of L-allonic and L-altronic acids. The inactivity of L-idono- and L-talono-γ-lactones was particularly interesting, because these compounds respectively differ from the L-gulono- and L-galactono-γ-lactones solely in the configuration of carbon atom 2.

These facts suggest that two analogous sequences of reactions can take place, as indicated in the accompanying schemes. A fundamental feature of both schemes is the change, at the second step, from the D- to the L-series with inversion of the whole molecule; and it is significant here that Horowitz, Doerschuk and King[3] have just shown that, in the rat, feeding of D-glucose labelled with carbon-14 at position 1 produces L-ascorbic acid labelled only at position 6. It appears that the enzymes catalysing the transformation of the aldonic acid into L-ascorbic acid are specific for an L-configuration of the hydroxyl groups on carbon atoms 2 and 5 (referred to L-ascorbic acid) and for the D-configuration on carbon atom 4.

During the above investigation, we found that D-arabo-ascorbic acid (the configuration of which differs from L-ascorbic acid only at carbon atom 5) was produced from two of the lactones, in the rat from D-mannono-γ-lactone *only* and in cress seedlings from D-altrono-γ-lactone *only*, and here the configuration of the hydroxyl group on carbon atom 3 was specific. We have not found, however, that the corresponding difference between the L-gulonic and L-galactonic acid γ-lactones has any obvious influence on the synthesis of L-ascorbic acid in the plant or





the animal. There is thus no indication which of our postulated reaction sequences is the more important.

Other mechanisms whereby hexoses might be transformed into L-ascorbic acid, involving L-glyceraldehyde, L-sorbose, D-sorbitol and D-gluconic acid, have not been found in cress seedlings or in the rat.

This work will be published in detail elsewhere.

F. A. Isherwood
Y. T. Chen
L. W. Mapson

Low Temperature Station for Research in Biochemistry and Biophysics, University of Cambridge and Department of Scientific and Industrial Research.

Dec. 6.

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[2] Jackel, S. S., Mosbach, E. H., Burns, J. J., and King, C. G., *J. Biol. Chem.*, **186**, 569 (1950).
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Light Pulses from the Night Sky associated with Cosmic Rays

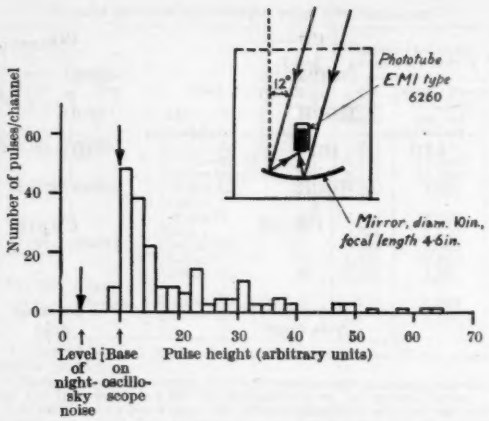
In 1948, Blackett[1] suggested that a contribution approximately 10^{-4} of the mean light of the night-sky might be expected from Čerenkov radiation[2] produced in the atmosphere by the cosmic radiation. The purpose of this communication is to report the results of some preliminary experiments we have made using a photomultiplier, which revealed the presence of light-pulses of short duration correlated with cosmic radiation.

A photomultiplier was mounted with its cathode at the focus of a parabolic mirror (see diagram, inset), the field of view of this 'telescope' being approximately ± 12° from the zenith. The output of the phototube was connected to an amplifier with equal differentiation and integration time-constants of 0·032 μsec. The apparatus was mounted in a field adjacent to this establishment at the centre of a square array of sixteen Geiger–Müller counters (each of area 200 cm.^{2}; the sides of the entire array were 180 metres) designed by Cranshaw[3] for studies of extensive air-showers. The results obtained were as follows.

(*a*) On the night of September 25–26, the pulses were first observed visually on the oscilloscope and were seen to be several times the mean height of the noise pulses due to the general night-sky illumination. Photographs of the pulses were taken and a pulse height distribution plotted (see graph). With the bias arbitrarily set at three times the night-sky noise, 97 pulses were recorded in 100 min.

Artificial night-sky noise was then produced by means of a small lamp inside a lid placed over the telescope. In 50 min., no noise build-up pulses were observed at the same bias and gain conditions.

(*b*) Three-fold coincidence pulses corresponding to showers detected by the extensive shower array were used to trigger the time-base of the oscilloscope, and the light pulses (if any) displayed on the *Y*-plates.



In nineteen such showers there was no evidence of any having associated light pulses.

(*c*) On the night of October 14–15, we decided to trigger the oscilloscope from the light pulses (again selected to be greater than three times night-sky noise) and display the pulses from all the sixteen single counters from the extensive shower array on the *Y*-plates. Out of fifty time-bases triggered (in 58 min.), eighteen had single Geiger–Müller pulses at the same point on the time-base; two had a coincidence between two Geiger–Müller tubes, one corresponding to three Geiger–Müller tubes and one to four Geiger–Müller tubes. This rate of observing Geiger–Müller pulses on the time-bases associated with light-pulses (when the association is to within 3 μsec.) is approximately a thousand times the accidental coincidence-rate. Moreover, the fact that all the Geiger–Müller pulses occur at the same point on the time-base and correspond in some instances to more than one counter being discharged strengthens the correlation between them and the light.

(*d*) On October 22, a night of complete cloud, when the cloud-base was known to be between 4,000 and 9,000 ft., pulses at about half the rate were observed under the same conditions of gain and bias.

The conclusions are: (i) a large fraction of the light pulses observed are directly correlated with the cosmic radiations; (ii) none of the light pulses may be attributed to spurious effects, for example, high-tension breakdown, electromagnetic pick-up or noise pile-up; (iii) from the steepness of the front of the electrical pulse, it is deduced that the duration of the light pulses is less than approximately 0·2 μsec.

The negative result of experiment (*b*), in which we observed no light pulses on the nineteen time-bases triggered from the showers, may be accounted for by the smaller angle of acceptance for the light by the telescope than for showers by the Geiger array.

Some of the light pulses observed may result from relatively soft showers high in the atmosphere from which only a few particles survive at sea-level. There is no evidence in the experiments carried out so far to show that the light is, in fact, Čerenkov radiation rather than light produced by ionization. A series of experiments is planned to investigate the exact nature of the phenomenon.

The above experiments were undertaken following a discussion with Prof. P. M. S. Blackett, to whom we are grateful for his continued interest. We wish to thank Mr. W. J. Whitehouse and Dr. E. Bretscher for their encouragement, and Dr. T. E. Cranshaw for the use of the extensive shower array.

W. Galbraith
J. V. Jelley

Atomic Energy Research Establishment,
Harwell, Didcot, Berks.
Nov. 19.

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Determinations of Size of Particles with the Electron Microscope

A method recently reported by Timbrell[1] for the determination of particle-size with the light microscope has been applied with slight modification to size determinations of textile-bonding agents with the electron microscope. These materials are dispersions of spherical polymer particles having sizes in the range 0–0·2 μ. The normal method of size determination involves measurements on photographic plates obtained at known magnification using a transparent graticule. This method, which is tedious, may be subject to errors due to fatigue of the operator; and the method described has been found much more rapid and reliable.

The photographs of the dispersion are obtained in the usual way with the electron microscope, and the plates are trimmed with a glass cutter so that they can be placed in the holder of an ordinary slide projector. The projected beam is intercepted and deviated on to a screen by a front-aluminized glass mirror which can be oscillated about a vertical axis. Size discrimination can then be made as in Timbrell's method, by the number of overlapping areas present on the screen, each representing a particle with a diameter larger than the amplitude of the oscillation. All the determinations made to date with the instrument have been obtained by counting overlapping areas for various settings of the amplitude control, thus giving the cumulative size-distribution curves.

It has been found advantageous to increase the visual effect of an overlap area by introducing a colour contrast in the following way. A circular sheet of 'Perspex' was dyed in two operations so that one half was red and the other half green. This was then

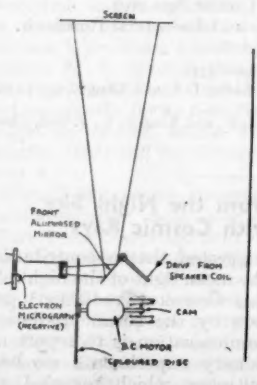

Fig. 1

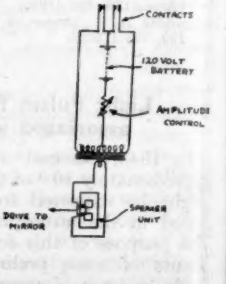

Fig. 2

mounted on the shaft of a small D.C. motor and placed in front of the projector. By rotating the disk in synchronism with the oscillation of the mirror, it could be arranged that the image of a particle at one end of its travel was red and at the other end green. When overlaps occurred they were formed by the additive combination of red and green light, and were yellow in colour and of a high visibility.

The synchronization of the motor and mirror was achieved by means of a rotary switch fastened to the motor spindle, which interrupted the current through the primary winding of a step-down transformer, the secondary winding of which was used to drive a small speaker-unit connected to the mirror. The power for the mirror drive was obtained from a 120-V. dry battery, and with this arrangement the amplitude of oscillation, which was controlled by a small rheostat in series with the battery, was independent of speed of motor over the range determined by fluctuations of the supply voltage. The rotary switch generated a square wave so that the mirror spent the greater part of the time at the ends of its travel. The definition was further improved by blacking out a sector of the 'Perspex' disk corresponding to the region of the oscillation cycle in which the mirror was moved.

The amplitude of oscillation for any setting of the rheostat was easily determined by measuring the movement of grains on the photographic plate, which when related to the scale on the plate gave the amplitude directly in microns. The optical arrangement used is shown in Fig. 1, and the circuit in Fig. 2.

If the rotating disk was omitted, the only unmodulated regions of illumination on the screen would be the overlaps (assuming the projector lamp to be supplied with direct current), and this property might be used as a basis for counting such areas automatically. This development is at present being investigated.

E. Atherton

Dyehouse Laboratories,
Imperial Chemical Industries, Ltd.,
Dyestuffs Division,
Blackley, Manchester.
Oct. 14.

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Coincidence and Overlap Errors in the Automatic Counting and Sizing of Particles

In the automatic counting and sizing of a population of particles on a glass slide or a photograph[1] errors arise when adjacent particles are closer than the limit of resolution of the counting apparatus or when they overlap along the scanning track: in both cases the two particles are counted as a single particle of larger size. If the centres of the particles are randomly distributed along the scanning track and the number counted is large, the probability that two successive centres will be less than a distance Z apart is

$$1 - \exp(-\alpha Z), \qquad (1)$$

where α is the mean number of particles per unit length of track. If the order in which particles are encountered along the scanning track is random with respect to size and their projections on the plane of the track are circular, the probability that the sum of the radii of two successive countable particles is between u and $u + du$ is:

$$Q(u)du = 2\,du \int_{D_1/2}^{u-D_1/2} P(x)\,P(u-x)\,dx, \qquad (2)$$

where $P(x)dx$ is the probability of a particle with radius between x and $x + dx$, and D_1 is the diameter of the smallest particle counted. The condition for resolution of the two particles is $Z \geqslant R_0 + u$, where R_0 is the limit of resolution of the counting apparatus. The coincidence error is given by the joint probability of (1) and (2), namely,

$$\varepsilon = 2\int_{D_1}^{D_2} \left[\{1 - \exp(-\alpha\overline{R_0 + u})\} \int_{D_1/2}^{u-D_1/2} P(x)\,P(u-x)dx \right] du, \qquad (3)$$

where D_2 is the diameter of the largest particle present. This expression does not allow for coincidences arising from particles that protrude into the scanning track although their centres lie outside it. If necessary, this allowance can be made by adding to $P(x)$ in the analysis the probability of an intercept length $2x$ when the particles are scanned by a line[2], given by the equation:

$$\varphi(2x) = x/(2\bar{r}).\int_{x}^{D_2/2} P(r)\,(r^2 - x^2)^{-1/2}\,.\,dr.$$

The particle radius r is a variable independent of x, and $\bar{r}$ is the mean particle radius.

Result (3) may be applied, for example, to a thermal precipitator sample of an airborne coal-mine dust. $P(x)dx$, the probability of a particle the projected area of which equals that of a circle of radius between x and $x + dx$, is approximately $K \exp(-\lambda x)dx$, where $\int_{D_1/2}^{D_2/2} K \exp(-\lambda x)dx = 1$, and D_1 and D_2 lie within the range 0·5–10 microns.

By substitution in (3),

$$\varepsilon = 2\int_{D_1}^{D_2} \left[\{1 - \exp(-\alpha\overline{R_0 + u})\} \int_{D_1/2}^{u-D_1/2} K^2 \exp(-\lambda u)dx \right] du. \qquad (4)$$

If $\lambda \gg \alpha$ ($\lambda = 0{\cdot}8$, $\alpha < 0{\cdot}02$ in this case), D_2 is much greater than D_1 and $\varepsilon \gg \varepsilon^2/8$, equation (4) simplifies to give:

$$\alpha = \varepsilon/\{2(D_1 + R_0)\}. \qquad (5)$$

The mean number of particle centres per unit length of track, α, is also $W\rho$, where W is the track width and ρ the mean number of particles exceeding D_1 in diameter per unit area of sample. The number exceeding 0·5 micron in diameter, here written ρ_0, is easy to measure, and $\rho = \rho_0 \exp\{-\lambda(2D_1 - 1)/4\}$. By substituting for α in (5),

$$W = \varepsilon \exp\{\lambda(2D_1 - 1)/4\}/\{2\rho_0(D_1 + R_0)\}.$$

No account has been taken of the irregular shapes of coal-mine dust particles, for which it can be shown that a rough allowance can be made by multiplying λ

by a factor of 0·8. Optical considerations place a lower limit of 1 micron on D_1. Typical values are ρ_0 is equal to one particle per 150 square microns, λ is 0·8, R_0 is 0·5 micron. To confine the coincidence error to 5 per cent of all particles greater than 1 micron, the permissible track width, W, is approximately 4·5 microns.

Equation (3) does not make a complete correction for coincidence effects when there are particles present which are smaller than the smallest particles that are to be counted, that is, particles the diameter of which is less than D_1. Coincidences in the size-range $D_1/2$–D_1 may give a signal above the threshold-level corresponding to D_1 and so a spurious count. This effect may be estimated by substituting the appropriate limits of integration in (3). In the case of the coal-mine dust above, these spurious counts would amount to about 0·4 per cent of the total count of particles greater than D_1. Similarly, an allowance is required if there are particles greater than D_2 present but not counted.

Where it is not necessary to size particles, the signals may be differentiated and a count made of the pulses corresponding to the leading edges of particles. The probability that the radii of two successive particles differ by an amount between v and $v + dv$ is:

$$2\,dv \int_{D_1/2}^{D_2/2-v} P(x)\,P(x+v)dx, \qquad (6)$$

and the condition for their resolution is $Z + v \gg R_0$. The coincidence error is then given by the joint probability of (1) and (6):

$$\varepsilon = 2\int_{0}^{(D_2-D_1)/2} \left[\{1 - \exp(-\alpha\,\overline{R_0 - v})\} \int_{D_1/2}^{D_2/2-v} P(x)\,P(x+v)dx \right] dv. \qquad (7)$$

If (7) is applied to a coal-mine dust sample with the assumptions $\alpha \ll \lambda$, $D_2 \gg D_1$ and $\varepsilon \gg \frac{1}{8}\varepsilon^2/8$, it simplifies to:

$$\alpha = \varepsilon/R_0. \qquad (8)$$

This is the same as the formula obtained by taking (1) as the coincidence error for a random distribution of leading edges with mean interval $1/\alpha$ and the condition $Z \gg R_0$ for resolution, where Z is now the interval between two successive leading edges. From (8) it is found that, when the coincidence error must be confined to 1 per cent of a count of all particles greater than 1 micron in a coal-mine dust sample, and when an allowance is made for irregular shape of particle, the permissible track width is approximately 5·5 microns.

I wish to thank the Director of the Safety in Mines Research Establishment, and the Ministry of Fuel and Power, for permission to publish this communication.

J. R. Hodkinson

Safety in Mines Research Establishment,
Portobello Street,
Sheffield 1.
Nov. 4.

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Scattering of 56-Mc./s. Radio Waves from the Lower Ionosphere

Incidental to radar studies of the aurora at Saskatoon, Canada (52·1° N., and 106·6° W.), with frequencies of 56 and 106·5 Mc./s., a persistent scatter echo is observed with the lower frequency. This echo arises apparently from the lower ionosphere. As viewed on a conventional range-amplitude display, the scattered signals appear extremely diffuse, but are quite evident on photographs of the display with exposures of a minute or more. A similar type of echo has never been detected at the higher frequency, although both radar units have about the same sensitivity and scan simultaneously the same parts of the sky.

For the 56-Mc./s. equipment, the aerial array-gain relative to a Hertzian dipole is about 16; the direction of maximum radiation is 6° above the horizontal; the peak power of the transmitter pulse, 50 kW.; the duration of the pulse, 16 μsec.; and the receiver sensitivity, 5×10^{-13} W. The following statements concerning this echo are based on fairly regular but not continuous operation of the radar units between February 23 and June 6, 1952. Since the primary purpose was to investigate radio echoes from the aurora, the normal operating period covered only the hours of twilight and darkness. However, a sufficient number of runs were made in the daylight hours at least to indicate the diurnal characteristics of the scatter echo.

The echo was strongest during March, decreasing in amplitude during April and May until finally it could only be detected by increasing the power output of the transmitter. It exhibited a minimum value in the late afternoon and increased steadily in amplitude throughout the night. The signal was strong in the morning hours; but the time that it reached a maximum is uncertain. There was no evident relationship between the scatter echoes and the occurrence of either visible aurora or radio echoes from the aurora.

The mean distance of the region from which the echoes arose was invariably about 400 km., extending over a range of about 100 km. for weak signals to about 200 km. for particularly strong ones. The photographic records showed a sharp minimum in the signal amplitude for distances of about 370 km. If this minimum in amplitude corresponds to the first minimum in the radiation pattern of the aerial (about 12° above the horizontal), the scattering region was about 85 km. above the earth's surface. The echoes showed no consistent variation with azimuth of the radar beam, although for periods of several minutes the signals from one direction would be slightly greater than those from other directions.

A similar type of signal has been observed at various times since 1948 by McKinley and Millman (private communication) in connexion with their meteor investigations at a frequency of 33 Mc./s. Their echoes arise apparently in a region directly above their station (Ottawa, Canada) at heights of 80–90 km. If, as seems very likely, the Saskatoon and Ottawa signals have a common origin, it must be one involving scattering rather than reflexion from horizontal stratifications of ionization in the lower ionosphere. It is also likely that these echoes arise in the region responsible for the long-range propagation of very high-frequency signals. If, as has been suggested recently by Booker *et al.*[1], such signals are due to scattering of the radio waves by

ionic inhomogeneities, the detection of back-scatter echoes indicates that the scale of the fine structure in the active region is a few metres rather than the hundreds of metres usually attributed to the *E*-region.

Grants and personnel (P. A. F.) from the Defense Research Board of Canada have made this work possible. The radar equipment was made available through the co-operation of the Geophysical Research Directorate, Air Force Cambridge Research Center, Cambridge, Mass.

P. A. Forsyth
B. W. Currie
F. E. Vawter

Physics Department,
University of Saskatchewan,
Saskatoon.
Aug. 20.

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A New Method of Light Microscopy

Using annular apertures made in a thin layer of candle soot on a microscope objective lens and corresponding apertures in the condenser, an ordinary microscope can be made very suitable for the study of unstained specimens. There are two different procedures.

To make higher refracting objects appear dark against a light background, it is necessary to find the objective lens surface nearest to the image of the condenser aperture and soot it by short contacts with the flame, until the transparency has diminished by one-half. On a watchmaker's lathe, using a sharp tip of some soft material, a narrow ring-shaped area is freed from soot, the diameter of the ring being greater than half the exit pupil of the objective, that is, at least twice as wide as the phase ring in conventional phase-contrast objectives. When compared with the latter, there are freedom from halo effects, increased resolving power and a pleasing gradation for objects having different refractivity.

Images of greater contrast and with light values similar to those to which we are accustomed in the macroscopic world are achieved if a partly reversed procedure is followed. The sooting is continued until the transparency has decreased to 8–9 per cent, after which the soot is wiped off, except for an area covering the image of the condenser ring aperture. As a result, the background of the microscope image appears in an agreeable sepia tone, often giving the illusion of sky-illuminated objects lying on the sand floor of a shallow sea. Many features which are generally invisible with the normal use of the microscope are rendered visible; for example, influenza virus on red cell ghosts, bacterial flagella, sperm tail pencil, and delicate membranous margins in living thrombocytes (see photographs). Apparently the method can be adapted to ultra-violet microscopy and mirror optics as well.

The theoretical explanation of what occurs in each of the alternative procedures may not be an easy one, since the phase effects in microscopical observation are still incompletely understood[1]. The arrangements described above are the result of some hundreds of trials, in which the conditions were varied one at a time.

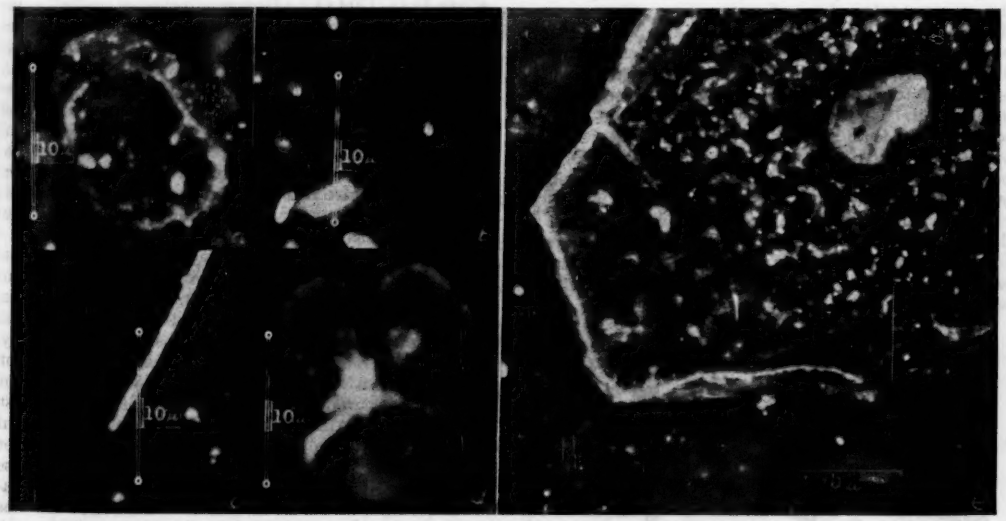
A. Wilska

Institute of Physiology,
University of Helsinki.
Nov. 17.

[1] See Proceedings of the London Conference on Optical Instruments, 131 (Chapman and Hall, 1951).

Photoelectric Control of the Compensator in Electrophoresis

Various types of compensator[1–3] are used in electrophoresis to bring the initial boundaries into view, or to bring a particular boundary into the correct position for isolation of a sample. Manual control of the compensator is quite convenient in these cases. However, it is sometimes necessary to keep a boundary stationary during a long run, either



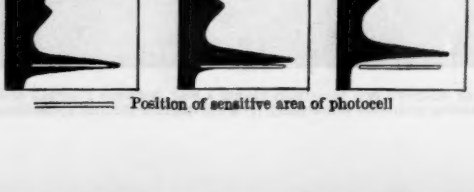
(*a*) Fowl erythrocyte membrane with adsorbed influenza *B* virus; (*b*) an unknown oral bacterium having a long flagellum; (*c*) tail of a human spermatozoon; (*d*) a group of living human thrombocytes with spreading membranous margins; (*e*) a cell from the gingival epithelium

for analytical purposes[4], or in the course of preparative work[5]. The obvious type of automatic control is one based on a photoelectric device; but no such application seems to have been described in the literature.

The main difficulty encountered in applying this principle arose from the very low intensity of the light which reaches the camera screen in the diagonal *Schlieren* optical system[6] of the Tiselius apparatus[1]. This prevented the use of ordinary photoelectric relays. Different ways of increasing the effective light intensity were considered and rejected for various reasons. Instead, it was decided to use a photoconductive cell of the type described by Schwarz[7]. Although the sensitive area is only 0·1 mm. × 10 mm., the sensitivity is very high (10 A./lumen). Moreover, the whole cell is compact (1 cm. diam. × 5 cm.) and can be operated from a small dry battery.

The following arrangement was finally adopted. The cell is situated with its photosensitive area in the focal plane of the camera (see Figs. 1–3), and connected in series with a 4·5-V. dry battery and a 'Cambridge' spot galvanometer, the latter being fitted with a variable shunt. A second Schwarz[7] photocell is held against the scale of the galvanometer, where it is illuminated by the light spot under particular circumstances. It is connected in series with a 13·5-V. dry battery and the coils of a small relay, the contacts of which control the supply of current to the compensator. It is particularly convenient to use the electrolytic type of compensator[3] here. The intermediate galvanometer relay is essential, because the very low light intensity differential between the bright and dark parts of the field (10^{-7} lumens) produces a current of the order of 1–2 μA., quite insufficient to operate a relay directly. The second photocell gives rise to a current of 3 mA., which is ample for the purpose.

The cycle of operations may be described as follows. With the system as shown in Fig. 3 the photocell in the *Schlieren* system produces its maximum current, causing the galvanometer light to fall on the other photocell. The relay is thereby actuated, and prevents the compensator from functioning. The current through the Tiselius apparatus then moves the boundaries until (Fig. 2) the first photocell is partly obscured and the light spot moves away from the second photocell, indirectly bringing the compensator into action. This is usually set to a rate 50–100 per cent greater than that which would, by continuous operation, keep the boundary stationary. Thus the boundary actually moves back while the compensator is in action until the original situation (Fig. 3) is restored, and the cycle recommences. Success is dependent on the stability of the maximum current from the first photocell. A superior arrangement, in which a certain amount of drift is permissible, is when the second photocell is between the positions



the light spot occupies when the first photocell is fully illuminated (Fig. 3) or in the dark (Fig. 1). Before the compensator is connected to the photoelectric control the boundary is brought to the appropriate intermediate position (Fig. 2), so that the galvanometer light falls on the second photocell. The system then cycles reliably, the boundary moving a small distance on each side of a mean position. It is necessary to bring the initial boundary to the correct level because, if the system is allowed to start from the extreme position shown in Fig. 1, the spot of light may sometimes swing completely past the second photocell. In order to prevent any failure due to the distortion or obscuring of the peak by condensed moisture it is the practice, particularly under humid conditions, to leave a current of air blowing over the external surfaces of the windows of the electrophoresis bath.

We wish to thank Mr. E. Schwarz, of Hilger and Watts, Ltd., for helpful advice.

R. L. Warren
P. A. Charlwood

Courtauld Institute of Biochemistry,
Middlesex Hospital Medical School,
London, W.1.
Aug. 20.

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A Crystalline Hydrated Magnesium Silicate formed in the Breakdown of a Concrete Sea-wall

During an investigation of a serious breakdown of a concrete sea-wall, a small amount of a finely divided soft white deposit has been found which gives an X-ray diffraction pattern not unlike that of $4CaO.Al_2O_3.13H_2O$. However, the chemical composition of the material, after allowing for 23 per cent impurity of calcium carbonate and 3 per cent of silica, can be expressed ideally as $4MgO.SiO_2.8{\cdot}5H_2O$. This is thought to be the first reported occurrence of a crystalline hydrated magnesium silicate formed at ordinary temperatures in the breakdown of a cement. Steopoe[1] has given indirect evidence of the formation of such a compound through the action of magnesium hydroxide on silica gel present in cement mortars decomposed by sulphate attack. The material reported on here has probably formed in a manner similar to that discussed by Steopoe. The magnesium hydroxide arises from the breakdown of calcium sulpho-aluminate through the presence of soluble magnesium salts derived from the sea-water[2]. The calcium sulpho-aluminate is, as is well known, a common product of reaction between calcium sulphate solutions and calcium aluminate. Silica gel can be expected to form readily from the poorly crystallized hydrated calcium silicates of the set cement under the decomposition conditions.

The X-ray diffraction pattern of the new material can be indexed to a hexagonal unit cell of spacings $a = 8{\cdot}95$ A., $c = 8{\cdot}10$ A. (cf. $a = 8{\cdot}8$ A., $c = 8{\cdot}2$ A. for $4CaO.Al_2O_3.13H_2O$ found by Wells, Clarke and McMurdie[3]). The c-axis has dropped by 0·16 A. over

several years, being originally 8·26 A. No weight is lost on heating from 110° to 160° C., but from here to 1,000° C. the material shows a continuous loss of close on 40 per cent of its air-dry weight. X-ray powder photographs show that the hydrated magnesium silicate, after losing 10·7 per cent structural water (3·1 molecules), is replaced at 340° C. by periclase (MgO) and a hydrated magnesium silicate of lower MgO content than the original material. The structure of the last is stable until about 650° when it, too, is destroyed. At 700° C. the reaction products recrystallize as periclase and forsterite ($2MgO.SiO_2$), together with a little unidentified material. These experiments suggest that the structural formula of the original material can be written as $3Mg(OH)_2.MgSiO_3.5{\cdot}5H_2O$.

Further work is proceeding on the properties and synthesis of the new material and its relation to other low-temperature forms of magnesium hydrated silicate, and a more detailed account will be published at a later date.

W. F. Cole

Division of Building Research,
Commonwealth Scientific and
Industrial Research Organization,
Graham Road,
Highett, S.21, Victoria,
Australia.
July 17.

[1] Stoopoe, A., *Tonind. Z.*, **60**, 487, 503 (1936).
[2] Lerch, W., Ashton, F. W., and Bogue, R. H., *Nat. Bur. Stand., J. Research*, **2**, 715 (1929).
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'Parathion' and Ultra-violet Light

Pure 'Parathion' is not at present considered to be an inhibitor of cholinesterase *in vitro*[1–3]. It is probable that those who first reported[4–6] to the contrary were using samples contaminated with one or more of the following: O-S-diethyl *p*-nitrophenyl thiophosphate, diethyl S-*p*-nitrophenyl thiophosphate and diethyl *p*-nitrophenyl phosphate ('Paraoxon'), all of which possess anticholinesterase activity *in vitro*[2].

We have found that when emulsions of 'Parathion' in aqueous salt solutions are exposed to ultra-violet light (wave-length 1850–4000 A.), they develop anticholinesterase activity progressively (Fig. 1,*c*). This activation occurred first at room temperature in emulsions and solutions (Fig. 1,*a* and *b*; Fig. 2) exposed to daylight. It did not occur in the dark (Fig. 1,*d*), or in electric light.

Estimation of the anticholinesterase activity developed has been carried out manometrically by the Warburg method. A homogenate of rat brain, or washed rat erythrocytes, has been used as source of cholinesterase, and 0·03 *M* acetyl-β-methylcholine chloride as substrate. The total volume of the flask contents has been 3·0 ml., and 'Parathion' solutions ($6{\cdot}9 \times 10^{-5}$ *M*) and emulsions ($3{\cdot}45 \times 10^{-4}$ *M*) have been sampled at the rate of 1·0 or 0·1 ml. per flask. The cholinesterase and 'Parathion' were incubated for 30 min. before addition of the substrate.

Activation of 'Parathion' in this way occurs in any of the following solvents: 0·85 per cent sodium chloride, *M*/40 sodium bicarbonate, *M*/15 phosphate buffer mixtures over the *p*H range 5·5–7·5, and in an *M*/20 borate buffer mixture, *p*H 8·5 (Fig. 2).

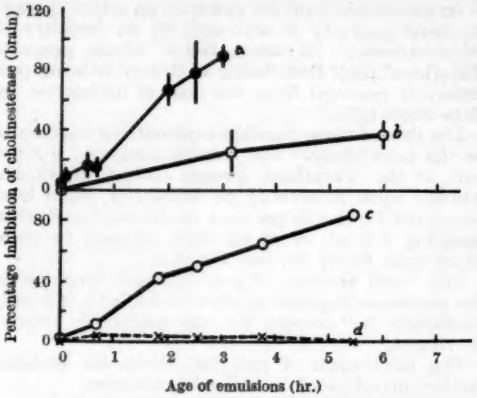

Fig. 1. Influence of light upon the development of anticholinesterase activity by emulsions of 'Parathion' (concentration $3{\cdot}45 \times 10^{-4}$ *M*) in 0·067 *M* phosphate buffer mixtures, *p*H 6·5. (*a*) and (*b*) Emulsions kept in daylight, sampling 1·0 ml. and 0·1 ml. respectively per Warburg flask. The vertical lines indicate the standard errors of 2–9 observations. Sunlight highly variable (August): room temperature range, 20–26° C. (*c*) Emulsions exposed at a distance of 2 ft. from an ultra-violet lamp. (*d*) Emulsions kept in darkness. Emulsions sampled at the rate of 0·1 ml. per flask. Room temperature, 25° C. ± 1°

The active inhibitor present in irradiated emulsions is destroyed by rat blood (that is, the plasma fraction) at a greater rate than that at which it combines with cholinesterase. For example, a volume of emulsion which caused 75 per cent inhibition of 20 mgm. brain caused no appreciable inhibition of 0·22 ml. whole blood, although these two quantities of enzyme preparations possess approximately equal cholinesterase activities. It is only when this same quantity of brain was completely inhibited that 10 per cent inhibition of blood could be detected.

At least three possibilities exist to account for this development of anticholinesterase activity in 'Parathion' emulsions or solutions exposed to sunlight or artificial ultra-violet radiation under the conditions stated: (1) 'Parathion' itself is being transformed

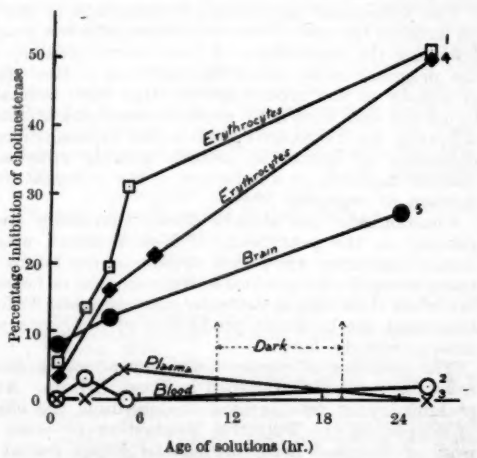

Fig. 2. Increase in anticholinesterase activity in solutions of 'Parathion' (concentration $6{\cdot}9 \times 10^{-5}$ *M*) exposed to daylight. Room temperature uncontrolled: 20–26° C. Solvents for 'Parathion': (1), (2), (3), 8·5 mgm./ml. sodium chloride; (4) *M*/15 phosphate buffer mixture, *p*H 5·5; (5) *M*/15 phosphate buffer mixture, *p*H 7·5

to an active inhibitor, for example, an active isomer; (2) some impurity is activated to an inhibitor of cholinesterase; (3) some factor which prevents 'Parathion' itself from being inhibitory is being progressively removed from the field of interaction by ultra-violet light.

The first of these possible explanations appears to be the most likely. The transformation of 0·3 per cent of the 'Parathion' present to an anticholinesterase equal in activity to 'Paraoxon' could have accounted for the 50 per cent inhibition found when sampling 0·1 ml. of an emulsion exposed to ultra-violet light for 2½ hr. (see Fig. 1,*c*).

The small amount of *p*-nitrophenol liberated in the emulsions exposed to ultra-violet light is totally inadequate to account for the inhibitory activity developed.

The mechanism of this transformation is being further investigated in these laboratories.

J. Payton

Industrial Hygiene Research Laboratories,
Imperial Chemical Industries, Ltd.,
The Frythe, Welwyn, Herts.
Sept. 16.

[1] Diggle, W. M., and Gage, J. C., *Biochem. J.*, **49**, 491 (1951).
[2] Aldridge, W. N., and Barnes, J. M., *Nature*, **169**, 345 (1952).
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Effect of a Copper Supplement to the Rations of Milking Cows

The prevention of symptoms of swayback in the offspring of ewes grazing on affected pastures in Britain has been shown to be effective when the pregnant ewe receives an additional supply of copper[1]. Sufficient copper for the proper metabolism of nervous tissue in the young animal appears to be provided if a single dose of copper is administered to the mother ewe within an hour or two of the birth of its lamb[2].

The widespread appearance of swayback in lambs on farms in the west of Scotland during the war years, following the application of lime to the grazings of the pregnant ewes, raised the question of the effect of copper on the production of other farm animals. Cows are not known to produce swayback-affected offspring, but it appeared possible that the conditioned deficiency of copper in animals grazing swayback pasture might cause a reduction in the butterfat production of lactating cows.

Cunningham[3] has already shown that dairy cows grazing on the peat lands of New Zealand, where copper-deficiency symptoms appear in the lambs of many sheep flocks, produce a larger amount of butterfat when their ration contains extra copper. Before treatment the butterfat production of the herds was disappointingly low.

The problem of copper deficiency affecting dairy cows has not been examined in Great Britain. As a preliminary, it was decided to determine the effect of copper on the butterfat production of cows in west of Scotland herds during the winter period of stall feeding.

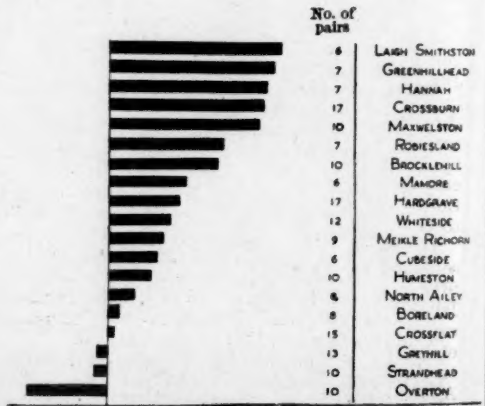
Milk recorders trained by the Scottish Milk Records Association at the West of Scotland Agricultural College determine the yield and the fat content of the milk produced by each lactating animal in the herds of all the members on at least one day during each month of the year. The results obtained by the recorders have been used in this investigation, which was conducted in nineteen different herds in nine counties in the south and west of Scotland.

In each herd two groups of animals were drawn up according to: (1) month of calving, (2) daily yield of milk, and (3) fat yield during the previous lactation. Two tests of the new lactation were regarded as minimal before an animal was put on experiment. Animals nearing the end of their lactation—all on experiment had calved less than eight months previously—were rejected if the yield of fat had dropped to less than 150 gm. of butterfat per day. One group was given supplementary copper, and the other served as control. To the production ration of each animal in the treated group one teaspoonful copper sulphate (10 gm. $CuSO_4.5H_2O$) was added. The inclusion of the full supplement of 10 gm. of the salt in less than a dairy scoopful of the meals (about 3½ lb.) was found to lead on many occasions to refusal of food. In such cases it was found necessary to administer the salt supplement in two doses (5 gm. per feed).

Addition of the supplement in the manner described to the rations of the experimental animals was made within one week of the visit of the recorder. In one herd—Crossburn—the addition of copper sulphate to the meal was delayed as late as the afternoon before the recorder's visit, that is, about 25 hr. before the recorder commenced his measurement of the yield of milk and of fat produced by the cows. Even when the supplement was fed at this late period the response elicited was most marked[4].

After the recorder had entered the results of the tests in the herd milk record book, the experimental results for the animals in the nineteen herds were examined statistically (see histogram). The observations were examined at Rothamsted Experimental Station, with the following result: weighted mean increase (gm.) butterfat per cow per day, 20·1; standard error, 5·22 (18 d.f.).

The treatment has, therefore, a real effect, although apparently not large enough to be detected on most single farms. The standard error is calculated from $SW\,(y - \bar{y}_w)^2$, where W is the number of pairs at a farm and is appropriate if the weights are inversely proportional to the within farm variances.



The results show that a significant increase in butterfat production has been obtained when additional copper is fed in the manner described to herds selected at random in the west of Scotland.

GEORGE DUNLOP

West of Scotland Agricultural College,
Auchincruive, Ayr.
July 14.

[1] Dunlop, G., and Wells, H. E., *Vet. Rec.*, **50**, 1175 (1938).
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Incidence of Meiosis in the Life-cycle of *Halidrys siliquosa* Lyngb.

SEAWEEDS belonging to the Fucales are diploid, and the reduction division has been shown to occur during the first nuclear divisions in both oogonia and antheridia[1–3].

During a recent investigation of the Fucales on the Northumbrian coast, we have found eight chromosomes in the vegetative cells of plants of *Halidrys siliquosa* Lyngb. The same number of chromosomes is present at both the first and second divisions in both oogonia and antheridia. This shows that in *Halidrys siliquosa* meiosis does not take place at the same stage of development as reported for other members of the Fucales. A detailed account of the cytology of this species will be published at a later date.

EVELINE ELLIOT
BETTY MOSS

King's College,
Newcastle upon Tyne.
August 29.

[1] Fritsch, "Structure and Reproduction of the Algæ", **2**, 370 (Cambridge: Univ. Press, 1945).
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Embryology of the Emperor Penguin (*Aptenodytes forsteri*)

E. A. WILSON[1] wrote in 1907, "The possibility that we have in the Emperor penguin the nearest approach to a primitive form not only of a penguin but of a bird, makes the future working out of its embryology a matter of the greatest possible importance". With this aim in mind he set out on June 27, 1911, with Bowers and Cherry-Garrard on a terrible journey[2] in the antarctic winter, during which three embryos were obtained from the Cape Crozier rookery on July 20. These specimens were described by Parsons[3], who considered that the smallest one corresponded to a chick embryo of ten days incubation, whereas the two larger specimens corresponded to chick embryos of thirteen days incubation.

It was not until 1949 that Stonehouse[4] collected a series of Emperor penguin embryos from a rookery fifty miles from one of the bases of the Falkland Islands Dependencies Survey. As a result of this expedition we now possess a new series of sixteen embryos collected between June and August and extending from the primitive streak stage to hatching. All the embryos, with one exception, are in an excellent state of preservation. The poorly preserved specimen was frozen before fixation. The embryos have been

Serial No.	Date of collection	Corresponding stage in chick	Incubation period in chick	Greatest length of curved embryo	Length from beak or maxillary process to tail
E 532	11.6.1949	3	12 –13 hr.	—	—
E 528	9.6.1949	16	51 –56 ,,	8 mm.	11·7 mm.
E 525	7.6.1949	19	3 – 3½ days	11·5 ,,	24 ,,
E 529	10.6.1949	22	3½– 4 ,,	10·6 ,,	35 ,,
E 530	10.6.1949	Poor state of preservation		10·4 ,,	34 ,,
E 536	18.6.1949	25	4½– 5 ,,	13 ,,	47 ,,
E 534	14.6.1949	27	5 – 5½ ,,	15 ,,	53 ,,
E 537	22.6.1949	29	6 – 6½ ,,	18·5 ,,	59 ,,
E 535	17.6.1949	30	6½– 7 ,,	18·5 ,,	63 ,,
E 533	12.6.1949	36	10 ,,	32 ,,	85 ,,
E 538	26.6.1949	37	11 ,,	35 ,,	92 ,,
E 541	6.7.1949	37	11 ,,	35 ,,	93 ,,
E 540	26.6.1949	38	12 ,,	40 ,,	99 ,,
E 539	26.6.1949	38	12 ,,	41 ,,	110 ,,
E 544	1.8.1949	Hatching	20 –21 ,,	105 ,,	299 ,,
E 545	2.8.1949	Hatching	20 –21 ,,	122 ,,	299 ,,

All measurements taken after fixation.

compared with and classified according to the normal stages of development in the chick[5]. The smallest nine specimens which were younger than those brought back by Wilson have been sectioned serially and confirm the observations made by Parsons[3] on the Gentoo penguin (*Pygoscelis papua*) and the Ring penguin (*Pygoscelis antarctica*). However, comparison of the development of the external form of the Emperor penguin with that of the chick and with that of other penguins already described, namely, Gentoo and Ring penguins by Parsons[6] and Gentoo and Adelie penguins (*Pygoscelis adelia*) by Waterston and Geddes[7], reveals a fact not yet recorded and worthy of note. In the earlier embryos the head region is relatively smaller, the neck and tail regions relatively longer, and the curvatures less well marked in penguin than in chick embryos. These features are more marked in Emperor penguin embryos and result in early penguin embryos resembling early reptilian embryos more closely than do early chick embryos.

It should be pointed out that the embryos collected on June 26 and July 6, 1949, have reached a stage of development similar to that reached by Wilson's largest specimens. This observation seems to confirm the ones made by Stonehouse[4] on measurements of hatched chicks by which he concluded that the chicks of the rookery at Cape Crozier were hatched about three weeks after the ones from the rookery from which the present series was obtained. A detailed description of the embryos is being written for publication in the near future in the Falkland Islands Dependencies Survey Scientific Reports.

T. W. GLENISTER

Department of Anatomy,
Charing Cross Hospital Medical School,
62 Chandos Place,
London, W.C.2.
Jan. 28.

[1] Wilson, Edward A., Aves. National Antarctic Expedition, 1901–4, Zoology II, Vertebrata No. 2, 1 (1907).
[2] Cherry-Garrard, Apsley, "The Worst Journey in the World", 2 vols. (London, 1922).
[3] Parsons, C. W., Penguin Embryos, British Antarctic (*Terra Nova*) Expedition, 1910, Natural History Report, Zoology, **4**, No. 7, 253 (1934).
[4] Stonehouse, Bernard, *Nature*, **169**, 760 (1952). "The Emperor Penguin (*Aptenodytes forsteri* Gray), 1, Breeding Behaviour and Development", Falkland Islands Dependencies Survey Scientific Reports (in the press, 1953).
[5] Hamilton, Howard L., Lillie's "Development of the Chick", 3rd edit. (New York, 1952).
[6] Parsons, C. W., "Discovery" Reports, VI, 139 (Cambridge, 1932).
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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 23

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. Jean Roche (Paris): "Comparative Biochemistry of Iodoproteins".*

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Room, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Mr. J. A. Chaldecott: "The Zograscope, a Forgotten Name in Optics"; Dr. H. Heywood: "A Brief Description of 18th Century Scientific Instruments recently discovered at Longleat, the Home of the Marquess of Bath".

UNIVERSITY OF LONDON (at Birkbeck College, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. P. Fallot (Paris): "The Tectonics of North Africa".* (Further Lectures on February 24 and 27.)

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. G. Anthony Gardner: "The Safety Factor in Construction", 1. (Cantor Lectures.) (Further Lecture, by Prof. F. C. Thompson, on March 2.)

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Dr. S. M. Manton, F.R.S.: "Progress of Soviet Planning in Central Asia".

Tuesday, February 24

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. G. B. Brown: "Is there a Philosophy of Science ?"*

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.15 p.m.—Mr. W. H. Cashmore: "Recent and Present Work at the N.I.A.E.".

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Dr. Georges Decharneux: "Industrial Medicine and Hygiene in Belgium".*

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. K. R. S Morris: "Tsetse Fly Control".

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. P. L. Mollison: "The Life-Span of Red Cells" ("The Scientific Basis of Medicine", 15).*

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (joint meeting with the PLASTICS AND POLYMER GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. E. K. Earp, Mr. S. Shapiro and Mr. A. E. Wiggs: "Resin Cements in Chemical Engineering"; Mr. V. Evans: "Corrosion-Resisting Properties of some Synthetic Resin Cements".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. D. T. Germain-Jones: "Geophysical Prospecting for Oil".

Wednesday, February 25

ROYAL SOCIETY OF MEDICINE, ENDOCRINOLOGY SECTION (joint meeting with the SOCIETY FOR ENDOCRINOLOGY, at 1 Wimpole Street, London, W.1), at 10 a.m.—Symposium on "Thyroid Gland".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. E. H. Browne: "Improving Coal Production" (Cadman Memorial Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. G. F. Peaker: "A Sampling Design used by the Ministry of Education".

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Discussion on "The Lighting of Equestrian Crossings".

Thursday, February 26

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 10.30 a.m.—Discussion on "The Floor of the Atlantic Ocean" (to be opened by Dr. E. C. Bullard, F.R.S.).

ROYAL INSTITUTE OF PHILOSOPHY (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.45 p.m.—Viscount Samuel: "Man's Ideas about the Universe".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. H. J. Pollard: "New Materials and Methods for Aircraft Structure".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (joint meeting with the FOOD GROUP, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 6.15 p.m.—"Pathogenic Organisms in Food" (Dr. C. Cockburn: "Epidemiology of Food Poisoning"; Dr. R. E. O. Williams: "Staphylococci and other Gram Positive Cocci"; Dr. Joan Taylor: "Enterobacteriaceæ").

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the South-East Essex Technical College, Longbridge Road, Dagenham), at 7 p.m.—Dr. K. G. A. Pankhurst: "The Physics and Chemistry of Detergent Solutions".

CHEMICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 7.30 p.m.—Prof. A. Tiselius: "Some Applications of the Separation of Large Molecules and Colloidal Particles" (Centenary Lecture).

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Chemistry and Interrelationship of Endocrine Systems and their Psychological Effects" (Chairman: Dr. A. S. Parkes, F.R.S.: Speakers: Prof. F. G. Young, F.R.S., Prof. Jean Roche, Prof. G. W. Harris).

Friday, February 27

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 10.30 a.m.—"The Assessment of Plant Pests and Diseases".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "Ocean Swell and Microseisms" (Chairman: Dr. G. E. R. Deacon: Speakers: Dr. M. S. Longuet-Higgins, Mr. J. Darbyshire, Prof. Maurice Ewing).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. J. F. Allan: "Wake Studies of Plane Surfaces".

BRITISH ASSOCIATION OF CHEMISTS (in the West Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6.30 p.m.—Dr. Herbert Levinstein: "Our Changing Chemical Industries—an Appraisement" (Hinchley Medal Address).

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. D. McMullan: "The Scanning Electron Microscope".

Saturday, February 28

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (in Room 151, Institute of Education, Malet Street, London, W.C.1), at 2.30 p.m.—Prof. P. E. Vernon: "The Personality of the Teacher" (Chairman's Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT ADVISORY OFFICER IN BACTERIOLOGY (with a degree in science or agriculture with bacteriology)—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (February 27).

ASSISTANT PHYSICIST (with a good honours degree in physics) to work on the 15 MeV. Linear Accelerator—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1, endorsed 'Physicist' (February 28).

DIRECTORSHIP OF STUDIES IN MEDICINE (combined with a Lectureship (or Assistant Lectureship) in a relevant subject, preferably physiology or anatomy)—The College Secretary, Girton College, Cambridge (February 28).

GENERAL ASSISTANT ENGINEER (Efficiency and Testing) at Divisional headquarters—The Divisional Secretary, British Electricity Authority, London Division, Generation House, Great Portland Street, London, W.1 (February 28).

HEAD OF THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (February 28).

LECTURER (Grade II or III) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Registrar, The University, Bristol 8 (February 28).

MATHEMATICIAN at a Ministry of Supply Research Establishment near Sevenoaks, to work in research team on advanced problems in fluid mechanics or on application of high speed electronic computers to mathematical research—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.20/53A (February 28).

PHYSICIST with experience of X-ray diffraction, at a Ministry of Supply establishment at Aldermaston—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.21/53A (February 28).

RESEARCH OFFICER (Senior Scientific Officer grade) (with membership diploma of the R.C.V.S. and a university degree, preferably in veterinary science)—The Secretary, Research Institute (Animal Virus Diseases), Pirbright, Surrey (February 28).

SCIENTIST, Grade II (with an honours degree in science or equivalent) in the No. 4 (Burnley) Area—The Divisional Establishment Officer, National Coal Board, North-Western Division, 40 Portland Street, Manchester 1 (February 28).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, Queen Mary College, Mile End Road, London, E.1 (March 2).

DEPUTY WORKS ENGINEER FOR ATOMIC ENERGY factory at Sellafield, for maintenance of nuclear piles and associated chemical plant with particular responsibility for steam, water and electricity supplies, workshops and instrumentation—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 423.

LECTURER (with an honours degree in electrical engineering, and practical experience in the field concerned) IN ELECTRICAL ENGINEERING concerned either with the application of automatic control systems to electrical machines or with electrical power system engineering—The Head of the Electrical Engineering Department, City and Guilds College, South Kensington, London, S.W.7.

MECHANICAL AND ELECTRICAL ENGINEERS for design, operation and maintenance of ground mechanical and electrical works services on R.A.F. and Civil Aviation Stations at home and overseas—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.290/52A.

MECHANICAL ENGINEER IN THE PUBLIC WORKS DEPARTMENT, Sudan—The Sudan Agent in London, Sudan House, Cleveland Row, London, S.W.1, quoting 'M/Engineer 1824'.

METALLURGIST (Scientific Officer grade) at the Ministry of Supply London headquarters, to assist in research and development on metallic materials for aircraft construction, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.33/53A.